C66-3152

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APOLLO EXTENSION SYSTEMS-LUNAR EXCURSION MODULE [redacted]

Payload Integration Addendum to Phase B Final Report [redacted]

Grumman Design 378B

prepared for

National Aeronautics and Space Administration
Manned Spacecraft Center
Advanced Spacecraft Technology Division
Houston, Texas 77058

by

Grumman Aircraft Engineering Corporation

VOLUME VI PROGRAM REQUIREMENTS [redacted]

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Title 18, U.S.C. ...
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... law.

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Contract No. NAS 9-4983
ASR 378B Addendum

January 1966

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PREFACE

This report presents results of the Payload Integration Addendum to the Phase "B" Preliminary Definition Study (Contract NAS 9-4983) the Lunar Excursion Module (LEM), for [redacted] Apollo Extension Systems (AES). The objective of the addendum study was to develop preliminary engineering and program definition data related to payload integration for Alternate Apollo LEM Missions. These missions are referred to, in this report, as Phase I Flights.

The volumes comprising this report follow:

I Experimenter's Handbook - LEM Utilization

II Mission Description Summary

- Part 1 Flight 507
- Part 2 Flight 509
- Part 3 Flight 511
- Part 4 Flight 214
- Part 5 Flight 216

III Engineering Studies/Mission Analysis

IV Engineering Studies/Experiment Definitions

- Part 1 Flight 507/511
- Part 2 Flight 509
- Part 3 [redacted] Flight 214
- Part 4 Flight 216

V Engineering Studies/Vehicle Design Integration

VI Program Requirements

VII Management Plan

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1. INTRODUCTION/SUMMARY

1.1 INTRODUCTION

This volume presents the results of the technical Program Requirements of the Phase B Addendum Study for the Integrated Phase I Lab missions of the Apollo Extension System (AES) Program. The objective of this study phase was to prepare a preliminary definition of the elements required to develop and integrate the payloads into the Phase I Labs.

1.1.1 Ground Rules

- No interference with the LEM Lunar Landing Program will occur.
- Phase I Labs will be manufactured as LEM spacecraft and modified at KSC.
- Minimum spacecraft modifications, with the installation of experiments placing the burden of accommodation upon the experiments rather than the Apollo hardware.
- Minimum modifications to Ground Support Equipment, Acceptance Checkout Equipment, and Manned Space Flight Network.
- Launch complex assignments are:
  - o Saturn V Flights LC 39
  - o Saturn IB LEM Lab Flights LC 37B
  - o Saturn IB CSM Flights LC 34
- Modifications and development to be compatible with spacecraft launch vehicle availability and launch schedules as defined in the Flight Mission Assignment Plan for AES Planning, ML-65-1, dated 7 August 1965.
- Phase D Production/Operations starts July 1966 for the Phase I Lab Program.

1.1.2 Assumptions

- For the Saturn IB dual launch missions, the AES/LEM Lab flights are assumed to be end-of-month launches.
- The Saturn V launched Phase I Labs are the first of the month launches.
- All major facilities used on the Apollo Program will be available for use in the Phase I Lab Program.
- The implementation phase is preceded by a final definition study of payload integration.

Sections 3 through 7 of this volume are an addendum to the Phase B Final Report, dated 8 December 1965, and as such the Phase B Final Report represents a datum upon which the technical Program Requirements of this volume are formulated. Therefore, if no changes or modifications are stipulated in the text of each section, it shall be understood that the data contained in the Phase B Final Report shall be applicable and in conjunction with the data presented herein.

As initially stated, the general purpose of the Phase B Addendum is to utilize a lunar landing LEM from production and convert it to an integrated Phase I Lab. The steps and terminology associated in the attainment of this objective are summarized as:

- LEM (Lunar Landing) + Modification Kit = Baseline Phase I Lab.
- Baseline Phase I Lab + Compatibility Package and Experiment Equipment = Integrated Phase I Lab.

The definitions of modification kit and compatibility package as used in this volume are defined:

- Modification Kit: A group of equipment packages to be installed on a LEM to achieve a baseline configuration. Installation of the kit requires removal of LEM hardware items.
- Compatibility Package: A group of equipment packages to be installed on a baseline lab for the experiments.

1.1.3 Mission Description

A Mission description and primary objectives summary, abstracted from the detailed Mission Descriptions volumes for each of the five Phase I Lab flights is included in the following subparagraphs.

1.1.3.1 Flight 507 Mission and Objectives

Flight 507 is, nominally, an 11-day/200-n.mi Earth polar-orbit mission. The flight spacecraft is injected into orbit by a Saturn V launch vehicle, and includes an Apollo Command/Service Module and LEM Lab. Experiment payloads are carried in Service Module, Command Module, and LEM Lab. The primary objectives of Flight 507 are:

- To qualify equipment, survey techniques, and crew scheduling intended for subsequent lunar survey missions.
- To acquire maximum terrestrial scientific data from Earth orbit using lunar survey equipment.

1.1.3.2 Flight 509 Mission and Objectives

Flight 509 is, nominally, a 13-day mission; 11 days of which are spent in synchronous equatorial Earth orbit. The flight spacecraft is injected into orbit by a Saturn V launch vehicle and includes an Apollo Command/Service Module and LEM Lab. Experiment payloads are carried in Service Module, Command Module, and Lab.

The primary objectives of Flight 509 are astronomical investigations to:

- Locate and analyze sources emitting in X-ray, UV, and radio frequencies.
- Analyze the Martian Atmosphere
- Test the validity of cometary theory by observing the formation and behavior of comet-like clouds.

1.1.3.3 Flight 214 Mission and Objectives

Flight 214 is a CSM-LEM Lab rendezvous mission, nominally, a 24-day combined CSM-LEM Lab. CSM Flight 215 rendezvous with Lab Flight 214. The Lab is launched (unmanned) 5 days before the CSM, and takes over CSM expendables supply (power, GOX, H_2O) approximately 14 days after CSM-LAB rendezvous. The flight spacecraft (CSM and Lab) is injected into low-inclination Earth orbits by the Saturn IB launch vehicles. Experiment payloads are carried in Command Module and Lab.

The primary objectives of Flight 214 are:

- Evaluation of advance sensors for rendezvous and docking with both cooperative and non-cooperative spacecraft.
- Assessment of performance of navigational sensors and their capability as components of on-board navigation systems
- Measurement of biomed/behavior data over an extended manned mission (24 days).

1.1.3.4 Flight 511 Mission and Objectives

Flight 511 is, nominally, a 5-day/30-n.mi low-inclination lunar orbit mission, with the translunar phase extending the CSM mission to a nominal 11 days. The flight spacecraft is injected into orbit by a Saturn V launch vehicle, and includes an Apollo Command/Service Module and LEM Lab. Experiment payloads are carried in the Service Module, Command Module, and LEM Lab.

The primary objectives of Flight 511 are to:

- Determine geological characteristics of the Moon using sensors operating in broad frequency spectra.
- Identify areas of scientific interest for future landing and exploration, plus certification that these sites are safe for LEM landing.
- Provide accurate metric data on the location of potential landing sites.

1.1.3.5 Flight 216 Mission and Objectives

Flight 216 is a CSM-LEM Lab rendezvous, a 30-day CSM, and a 20-day Lab mission. The CSM (Flight 217) rendezvous with LEM Lab (Flight 216). The Lab is launched (unmanned) 10 days after the CSM and takes over CSM expendables support (power, GOX, H_2O) after approximately 4 days. The flight spacecraft (CSM and Lab) are injected into low-inclination Earth orbits by Saturn IB launch vehicles. Experiment payloads are carried in Command Module and Lab.

The primary objectives of Flight 216 are:

- Assessment of man's effectiveness in space using advanced procedures and equipment for extra vehicular activity.
- Measurement of biomed/behavioral data during an extended manned mission (30 days).

1.2 SUMMARY

Each of the technical Program Requirements that were evaluated during this study are summarized in the following sequential subparagraphs.

1.2.1 Schedules

The schedules are compatible with launch vehicle availability and launch dates as defined in the Flight Mission Assignment Plan for AES Planning, ML-65-1, dated 7 August 1965. The development schedule was formulated with the intent to minimize the quantity and duration of test activities consistent with the requirements to demonstrate the performance of each of the Phase I Lab designs. The Program

Schedules summarize the major development activities and operational milestones for each of the spacecraft and the experimental payloads.

1.2.2 Test

A development test plan has been developed which describes the tests required to accomplish the experiment payload integration for each Phase I Lab mission. This plan complements the Development Test Plan, Volume XIX of the AES-LEM Phase B Final Report. Included are test constraint logic diagrams which identify the test program constraints and milestones as a function of the payload integration program performed at Grumman (Bethpage), and the modification, checkout, and launch effort performed at KSC. This relationship of tasks must be scheduled and coordinated, thereby critically dependent activities are satisfactorily completed before beginning other activities. The test requirements for each mission configuration are identified in this test plan as follows:

- Compatibility equipment development test and hardware quantity requirements
- Payload integration system test requirements
- Mission support requirements
- Test program constraints

1.2.3 Manufacturing

A manufacturing plan has been generated for the integration of the compatibility packages and experiment payloads at KSC to convert LEM spacecraft to Phase I Lab mission configured spacecraft. This plan supplements the one included in Volume XVII, Manufacturing Plan, Phase B Final Report in that it assumes parallel installation and verification of the per flight compatibility packages with the baseline modification kit. The activities identified minimize the requirements for facilities and optimize the schedule without compromising the quality of workmanship and reliability of the spacecraft.

At Grumman (Bethpage), the compatibility packages are assembled and verified for installation fit and acceptability prior to shipment to KSC. This procedure minimized the installation and verification tasks at KSC.

An analysis was made of the location of the site for accomplishment of the modification of the LEM's to Phase I Lab mission configured spacecraft. This analysis was based on the spacecraft configuration for Flight 507. The results indicate that costs and schedules are generally unaffected by site location with the greatest saving realized when the "in-line" buildup concept is applied.

1.2.4 Operations

An operations plan, supplementing Volume XVI "Prelaunch and Mission Operations" of the Phase B Study, has been generated which defines the KSC prelaunch activities and flight test objectives for the Phase I Lab missions.

The checkout concepts and criteria, test approach, resulting test requirements, and typical Phase I Lab/Payload operations schedule are presented. This schedule reflects the integration of both modification and checkout functions to be accomplished at KSC. Finally, the payload checkout support requirements for Ground

Support Equipment (GSE), Acceptance Checkout Equipment/Spacecraft (ACE/SC), and Facilities are summarized on a pre-flight basis.

The flight test objectives were determined and summarized on a pre-flight basis.

1.2.5 Support

The support plan identifies the GSE required for experiment payload integration of the Phase I Lab. This plan complements the Support Plan, Volume XXII of the AES-LEM Phase B Final Report. Included is a Training Plan and Transportation Plan which specifies the requirements and equipment necessary for each Phase I Lab mission. Functional Block diagrams are included which portray the relationship between the experiments, compatibility package, and the associated GSE.

1.2.6 Facility

Facility requirements, over those specified for the basic Phase B Program, to support the payload integration tasks for the Phase I Labs are as follows:

- No new Grumman or NASA-MSC facilities are required.
- Increased usage is required of existing Grumman and NASA-MSC facilities.
- Additional area is required at the KSC to support the manufacturing tasks and checkout equipment, to install experimental payloads into the baseline Phase I Lab, and to verify the integrated payload.

1.3 CONCLUSIONS

Major conclusions resulting from the study are as follows:

- Approximately 15 1/2 weeks are required to accomplish the manufacturing and installation system verification type tasks to modify LEM's to Phase I Labs. No additional work stations are required beyond those identified for conversion of a LEM to the baseline Phase I Lab. A substantial schedule and facility savings can be effected by accomplishing the modifications as an "in line" modification.
- The existing and planned facilities for Apollo, plus the facility additions reported in the basic Phase B Study, are sufficient when considering the demands of the Payload Integration tasks.
- The experimenter should qualify his experiment nominally 12 months prior to flight date, to permit final integration system verification tests of qualified equipment.
- The experimenter should deliver his flight article experiment nominally 7 months prior to flight date.
- To be consistent with the Apollo Program, ACE-S/C will be employed as the primary means of Lab/Payload checkout. Therefore, adaptability between ACE-S/C and experiment will depend upon the inclusion of ACE-S/C checkout capability into the design of the experiment.
- In performing the development and payload integration tests, an additional descent stage is required which permits configuration changes to be performed at Grumman (Bethpage) at the same time that earlier mission configurations are in progress.

1.4 RECOMMENDATIONS

Major recommendations resulting from the study are as follows:

- Conduct a detailed study of the factors concerning building the Phase I Lab as in-house production vehicles.
- Evaluate the effect of accomplishing all the modifications on the descent stage and fabrication of final configuration at Grumman (Bethpage). This stage would be substituted for a LEM descent stage at KSC. Controls and displays would be incorporated in a module to fit within the ascent engine compartment with access through the engine cover.
- Conduct a detailed study of the facilities necessary for mission support. The philosophy of mission support should be expanded to ascertain the degree of operational readiness that is required for each Phase I Lab mission.
- Detailed review of interface definitions and alternatives for CSM/Lab, MSFN/Lab, Compatibility Equipment/Lab, and Compatibility Equipment/ Equipments.
- Screen experiments to identify those incompatible with flight launch schedule - clarify schedules for candidate experiments including preliminary/final definition studies and durations required to develop hardware from go-ahead to flight hardware delivery.
- A detailed review is required of KSC facility utilization and prelaunch checkout procedures from KSC arrival to launch.
- Compare advantages/disadvantages of installing experiment hardware during prelaunch checkout at KSC versus carrying "all-up" spacecraft through the complete checkout process.
- Evaluate schedule of experiment installations relative to the activities conducted at the prelaunch checkout facilities.
- Identify experiment installations sequences to minimize facility modifications required to accommodate the experiment payloads.

2. SCHEDULES

2.1 PROGRAM SCHEDULES

The preparation of schedules for the Phase I LEM Lab Program and each mission was based on the 1 July 1966 Phase D go-ahead date and the Phase I LEM Lab flight schedule, as identified in ML-65-1. Figure 2.1-1 summarizes the pertinent phases of the Phase I Lab schedules for each of the five missions. Figures 2.1-2 through 2.1-6 summarize the major developmental activities and operational milestones for each of the spacecraft and the experimental payloads.

2.2 DEVELOPMENT SCHEDULE

The Development Schedule, Figure 2.2-1, identifies the major elements of the experiment payload integration, development, verification, and demonstration activities for the Phase I LEM Lab Program. The approach used in the preparation of the schedule consisted of:

- Identification of the constraints for each mission
- Relation of one constraint to another, and to the final assembly and checkout of the flight article
- Quantity of test articles required and their configuration
- Facility utilization

Every effort was made to minimize the quantity and duration of test activities consistent with the requirement to demonstrate the performance of the Phase I LEM Lab designs. The schedule generated provides for a demonstration of experimental payload spacecraft integration for each of the four flight designs with a minimum of test articles.

The schedule includes the developmental activities of the major assemblies of the compatibility package to highlight their relationship to the system level events of each flight. Simulation activities have been included for facility utilization scheduling, and because they assist in the verification of total system performance.

An important feature of the payload integration schedule is the maximum utilization of the existing baseline Lab test articles and facilities previously described in the Phase B Final Report, Ground Development Test Plan, Volume XIX. A descent stage is the only additional test article required, and it permits reconfiguration modifications to be performed at Grumman at the same time that tests for earlier mission configurations are still in progress. The use of an extra descent stage is particularly effective since it carries the greater burden of the structural changes from one flight configuration to the next.

Mission support is the capability for performing tests and simulations during the flight to aid in the diagnosis of any equipment malfunction or activity related contingency. Mission support requires the readiness of an integrated experiment payload/spacecraft system in a man-in-the-loop configuration. Mission support has been provided with the system test article at MSC, and also with the Flight Control Integration (FCI) Simulator at Grumman.

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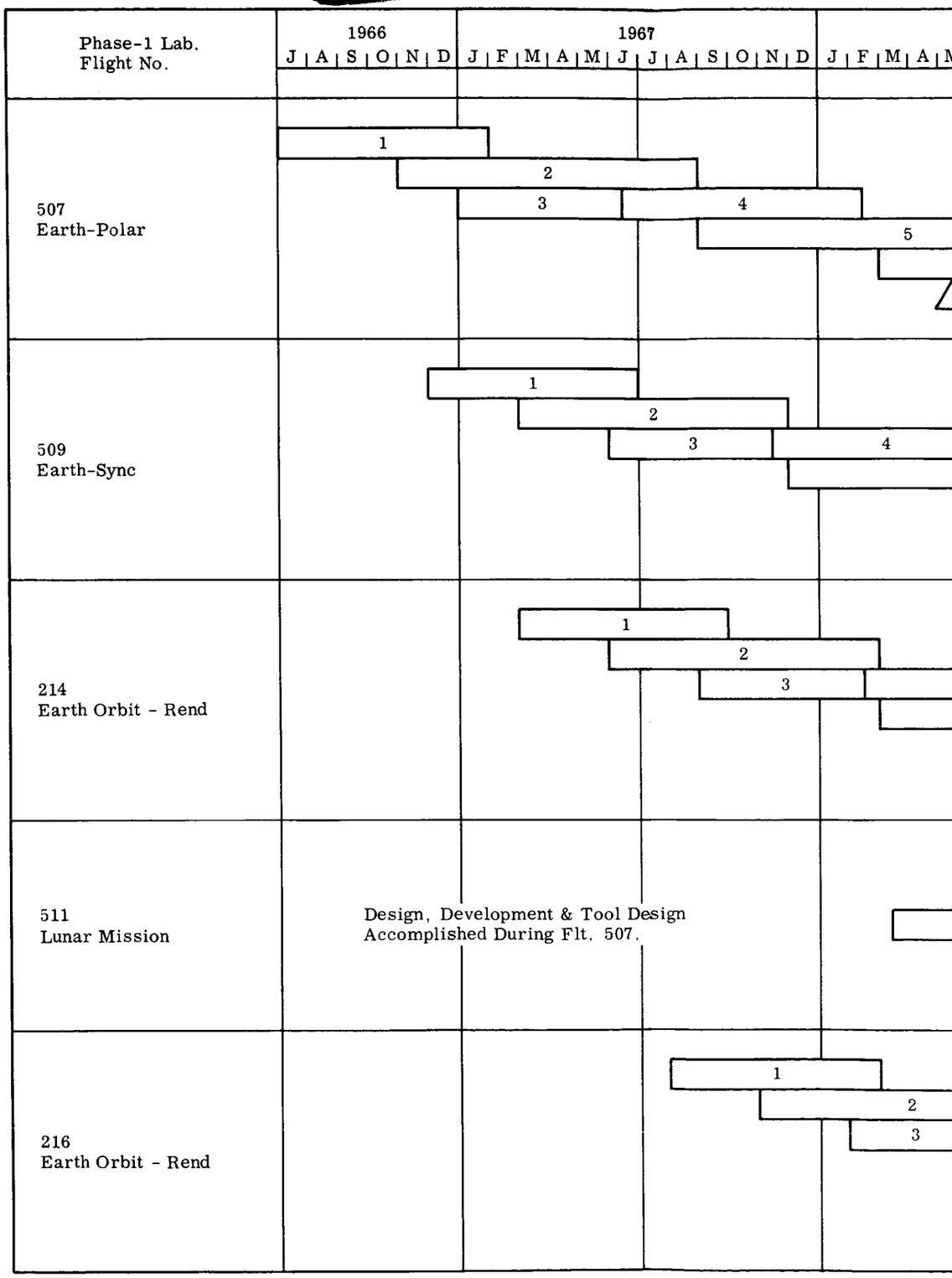

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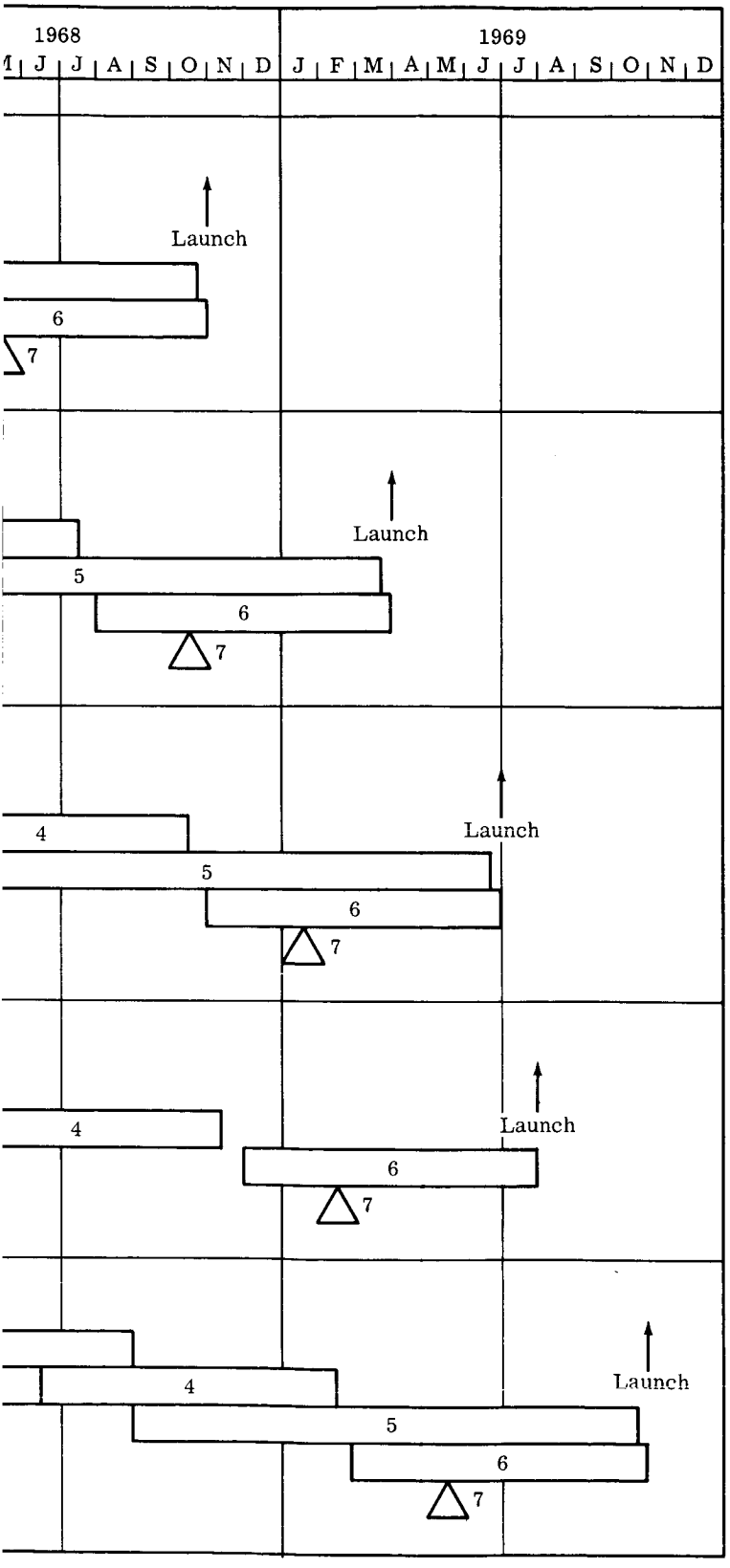
2.1.1-1



1 Design

2 Development

3 Tool Design

4 Tool & Compatability Kit Fabrication

5 Verification

6 Modification & Prelaunch Checkout

7 Start Expt. Installation

Figure 2.1-1 Summary Program Schedule

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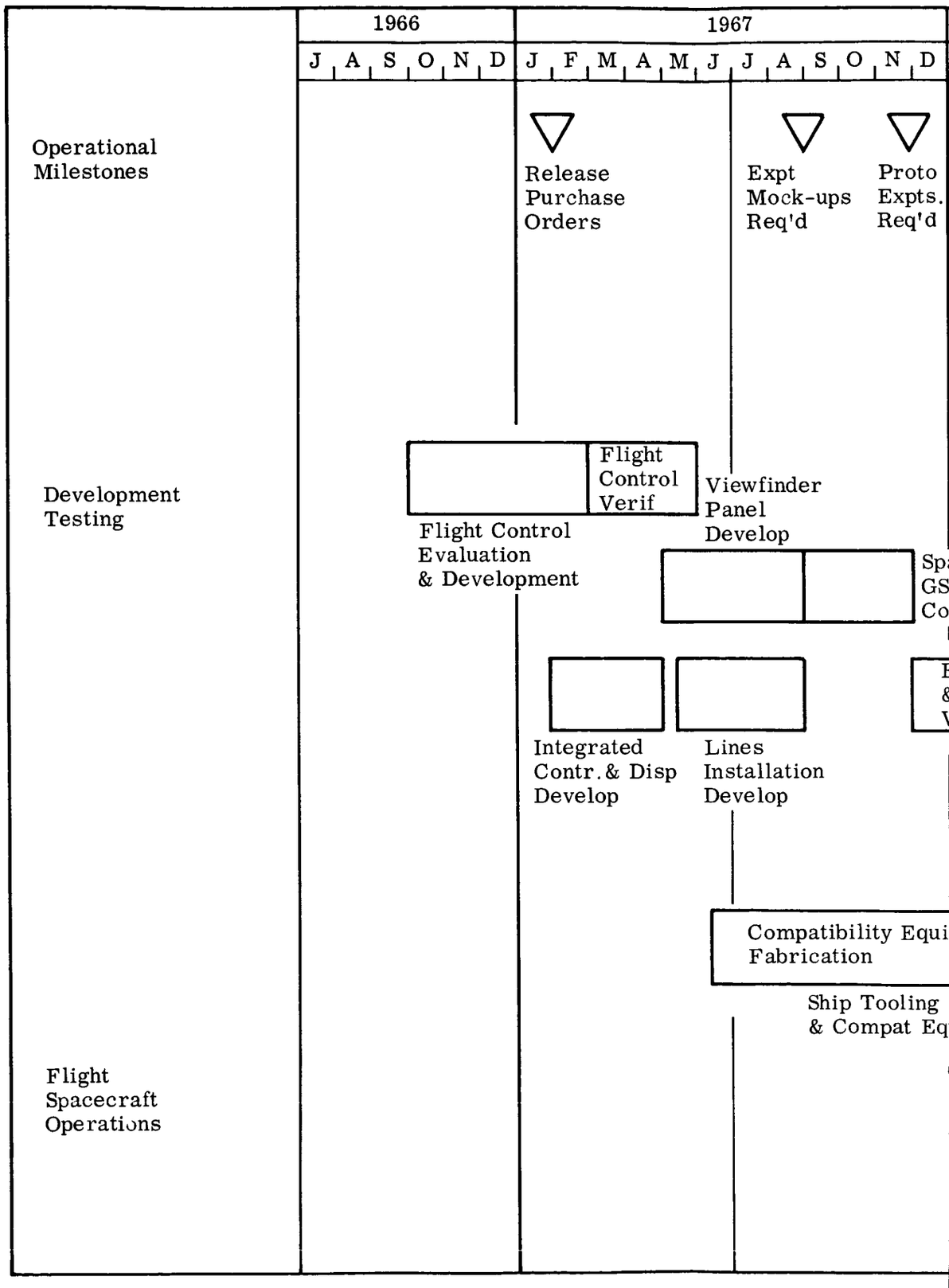
1966
1967
J A S O N D
J F M A M J J A S O N D
Operational Milestones
Release Purchase Orders
Expt Mock-ups Req'd
Proto Expts. Req'd
Development Testing
Flight Control Verif
Flight Control Evaluation & Development
Viewfinder Panel Develop
Integrated Contr. & Disp Develop
Lines Installation Develop
Compatibility Equi
Fabrication
Ship Tooling & Compat Eq
Flight Spacecraft Operations

2.1.2-1

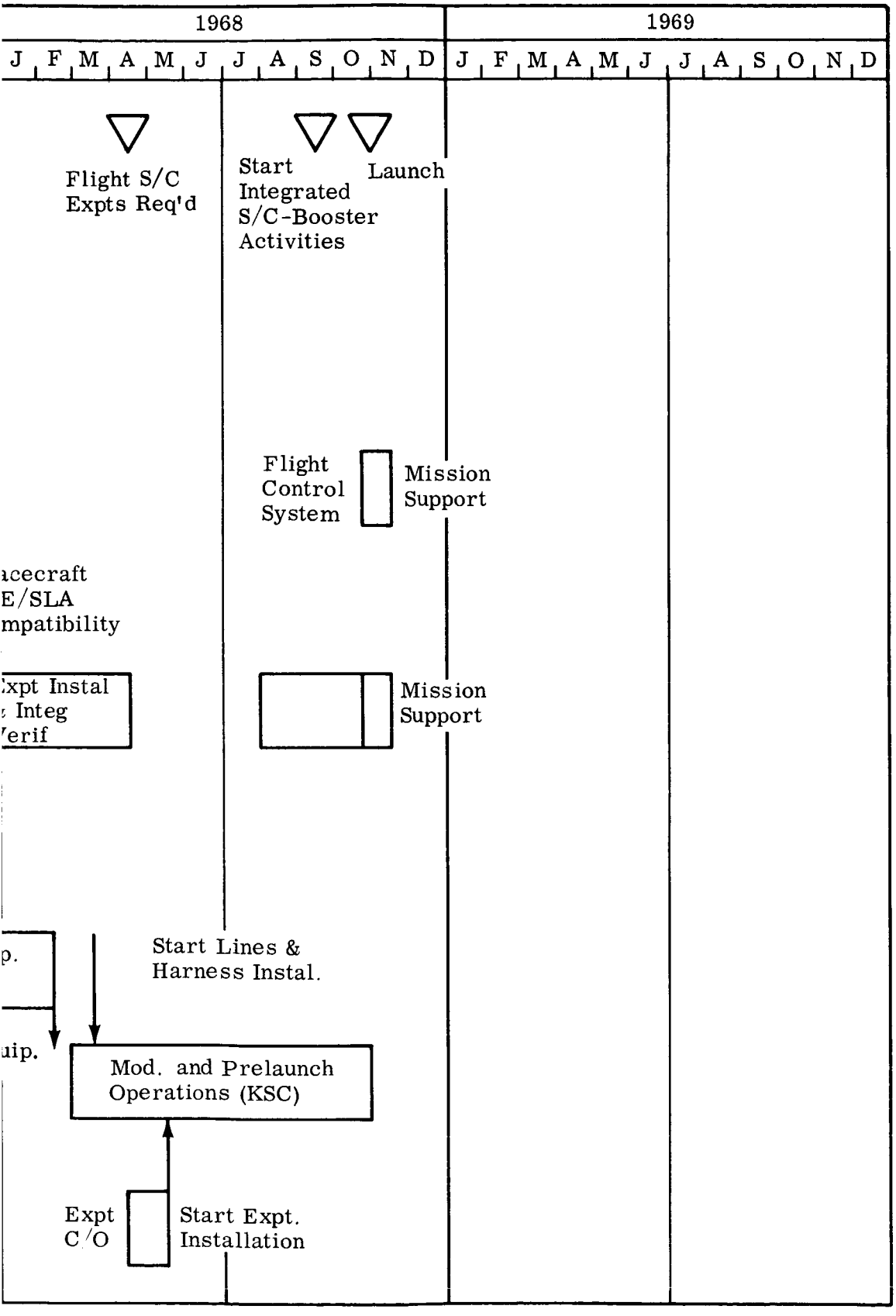

Figure 2.1-2 Flight 507 Development Schedule

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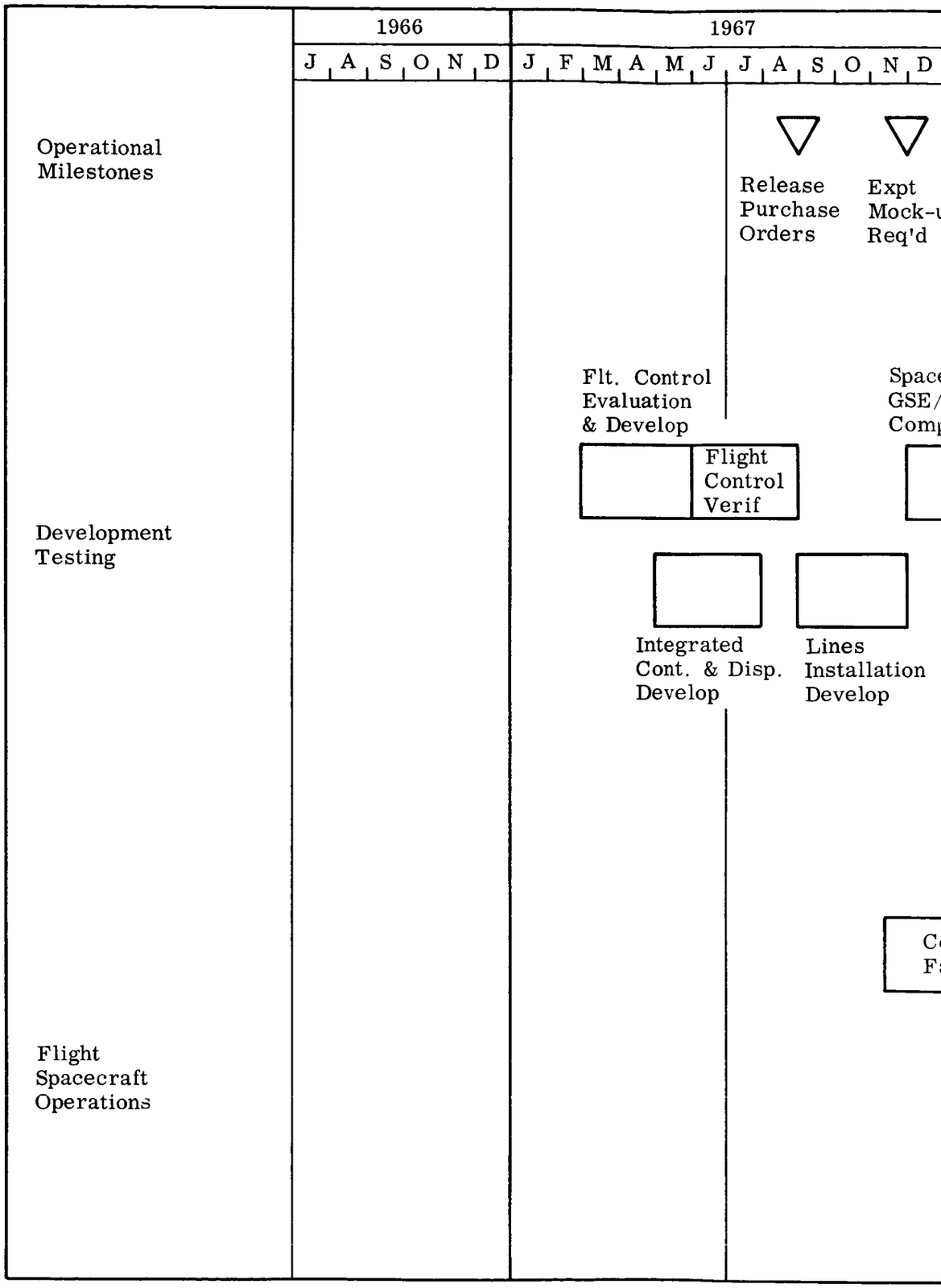

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2.1.3-1

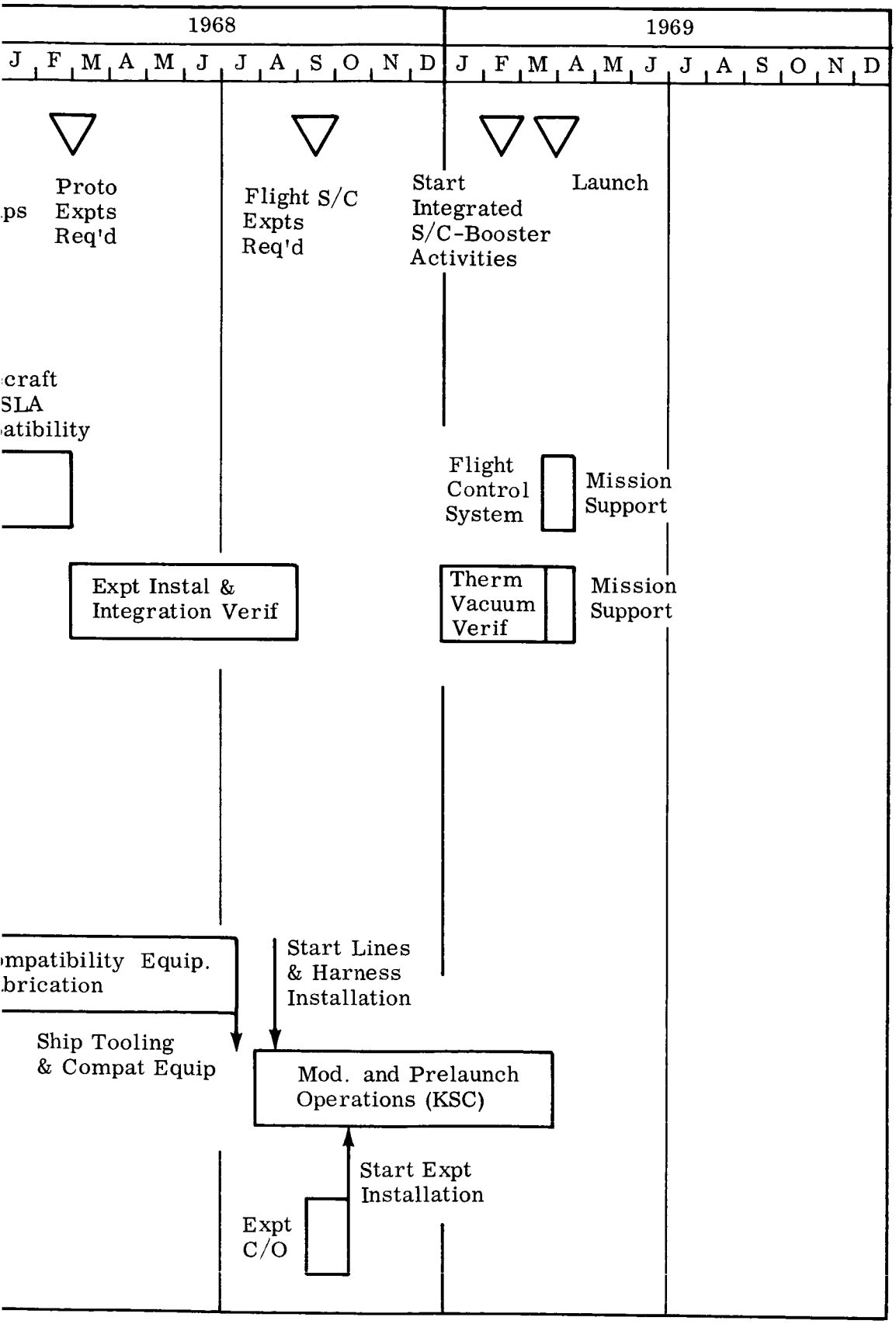
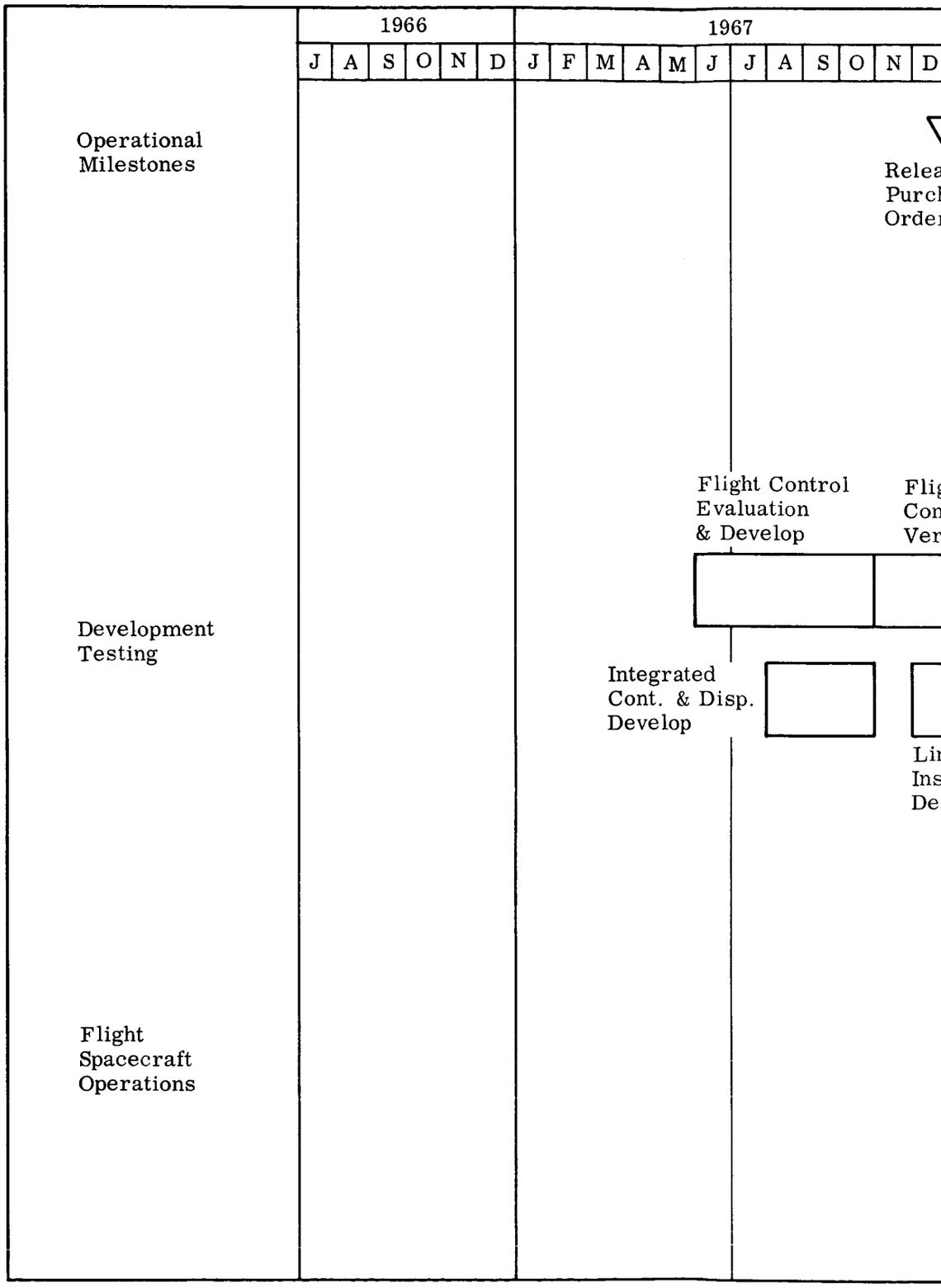


Figure 2.1-3 Flight 509 Development Schedule

Grumman


1966
1967
J A S O N D J F M A M J J A S O N D
Operational Milestones
Relea
Purch
Order
Flight Control Evaluation & Develop
Flig
Con
Ver
Development Testing
Integrated Cont. & Disp. Develop
Lin
Ins
De
Flight Spacecraft Operations

2.1.4-1

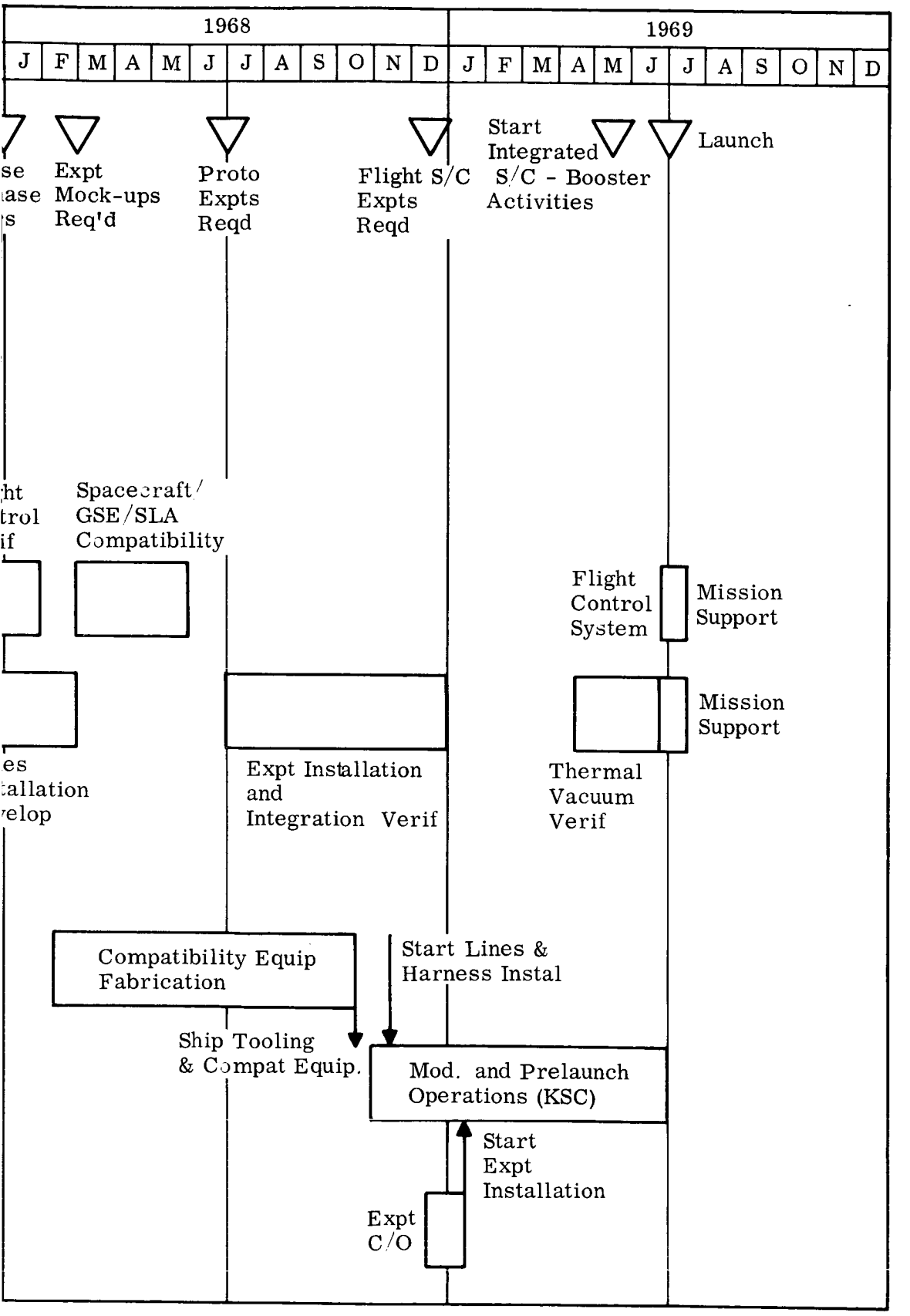
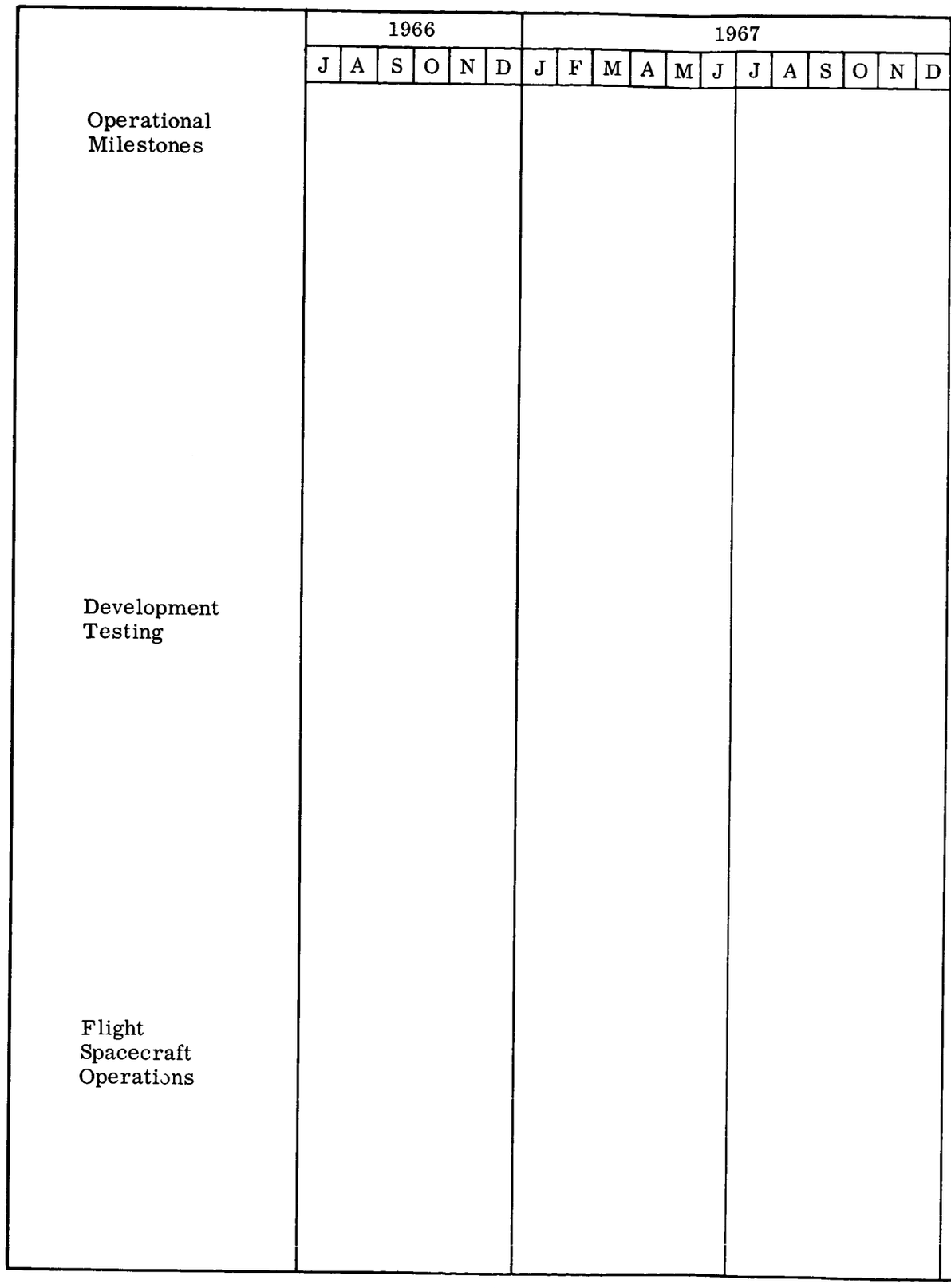

1968
1969
J F M A M J J A S O N D J F M A M J J A S O N D
Expt Mock-ups Req'd
Proto Expts Reqd
Flight S/C Expts Reqd
Start Integrated S/C - Booster Activities
Launch
Spacecraft/ GSE/SLA Compatibility
Flight Control System
Mission Support
Mission Support
Expt Installation and Integration Verif
Thermal Vacuum Verif
Compatibility Equip Fabrication
Start Lines & Harness Instal
Ship Tooling & Compat Equip.
Mod. and Prelaunch Operations (KSC)
Start Expt Installation
Expt C/O

Figure 2.1-4 Flight 214 Development Schedule

[redacted]



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2.1-5-1

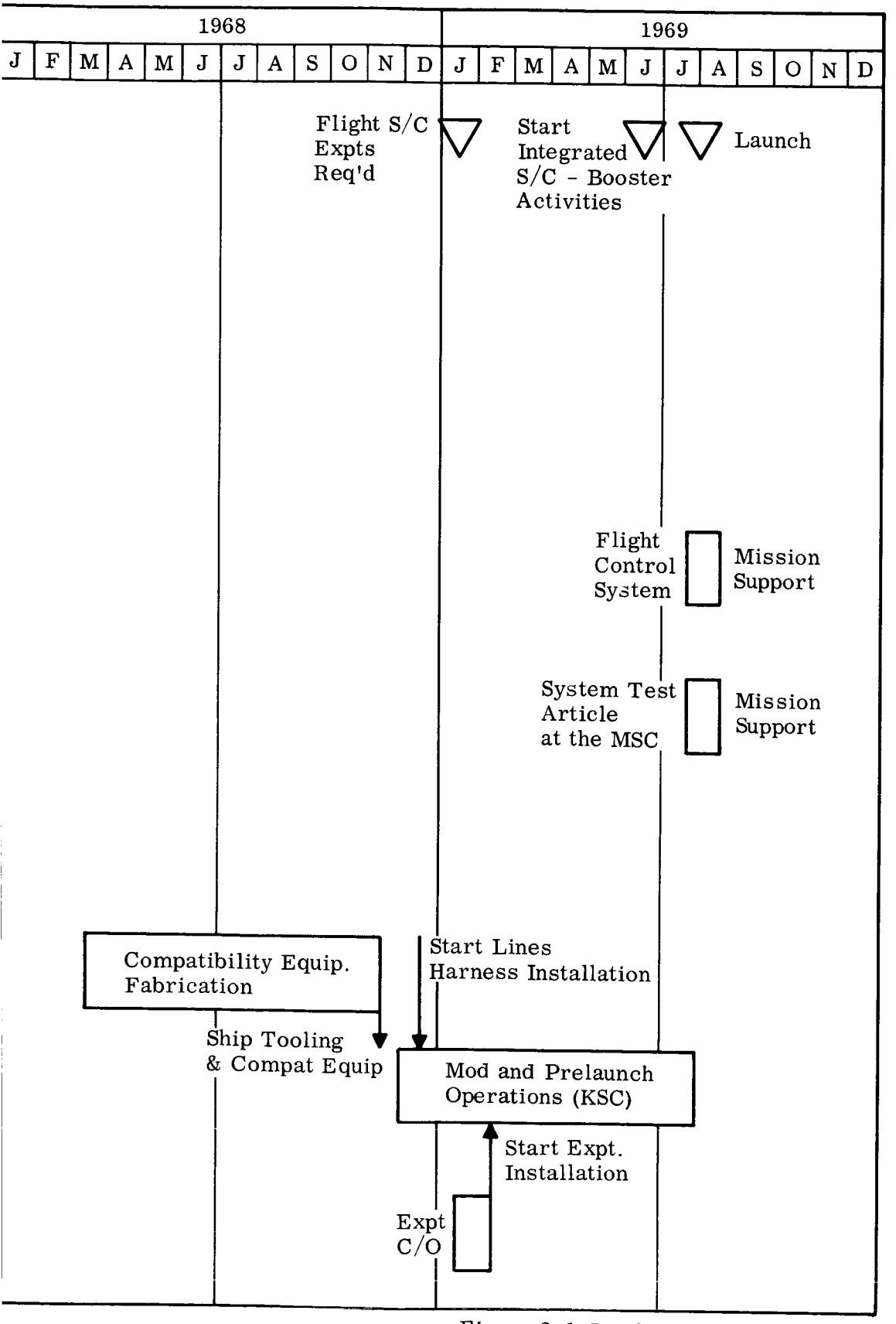
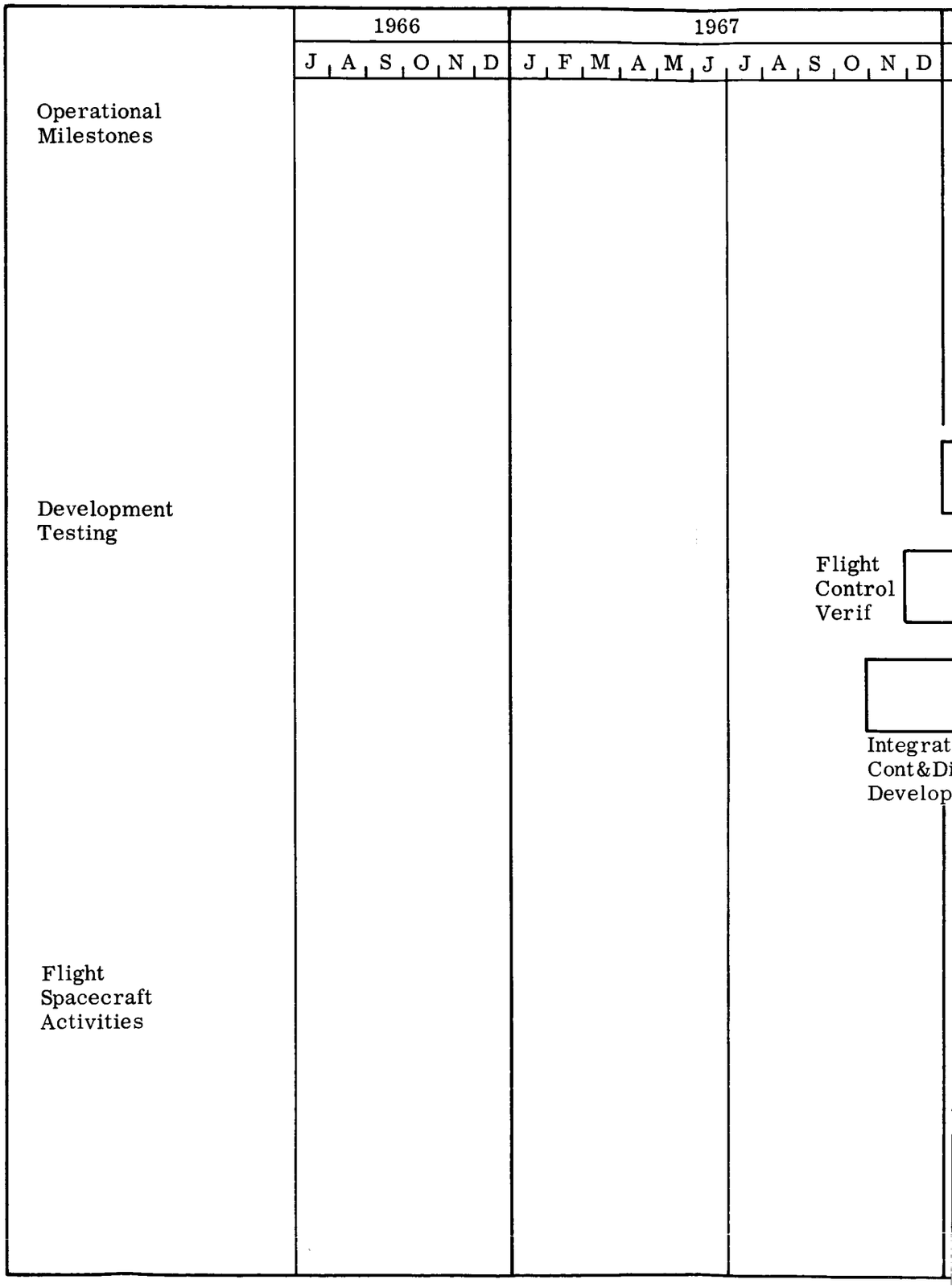

1968
1969
J F M A M J J A S O N D J F M A M J J A S O N D
Flight S/C Expts Req'd
Start Integrated S/C - Booster Activities
Launch
Flight Control System
Mission Support
System Test Article at the MSC
Mission Support
Compatibility Equip. Fabrication
Start Lines Harness Installation
Ship Tooling & Compat Equip
Mod and Prelaunch Operations (KSC)
Start Expt. Installation
Expt C/O

Figure 2.1-5 Flight 511 Development Schedule

[redacted]

Grumman

[redacted]



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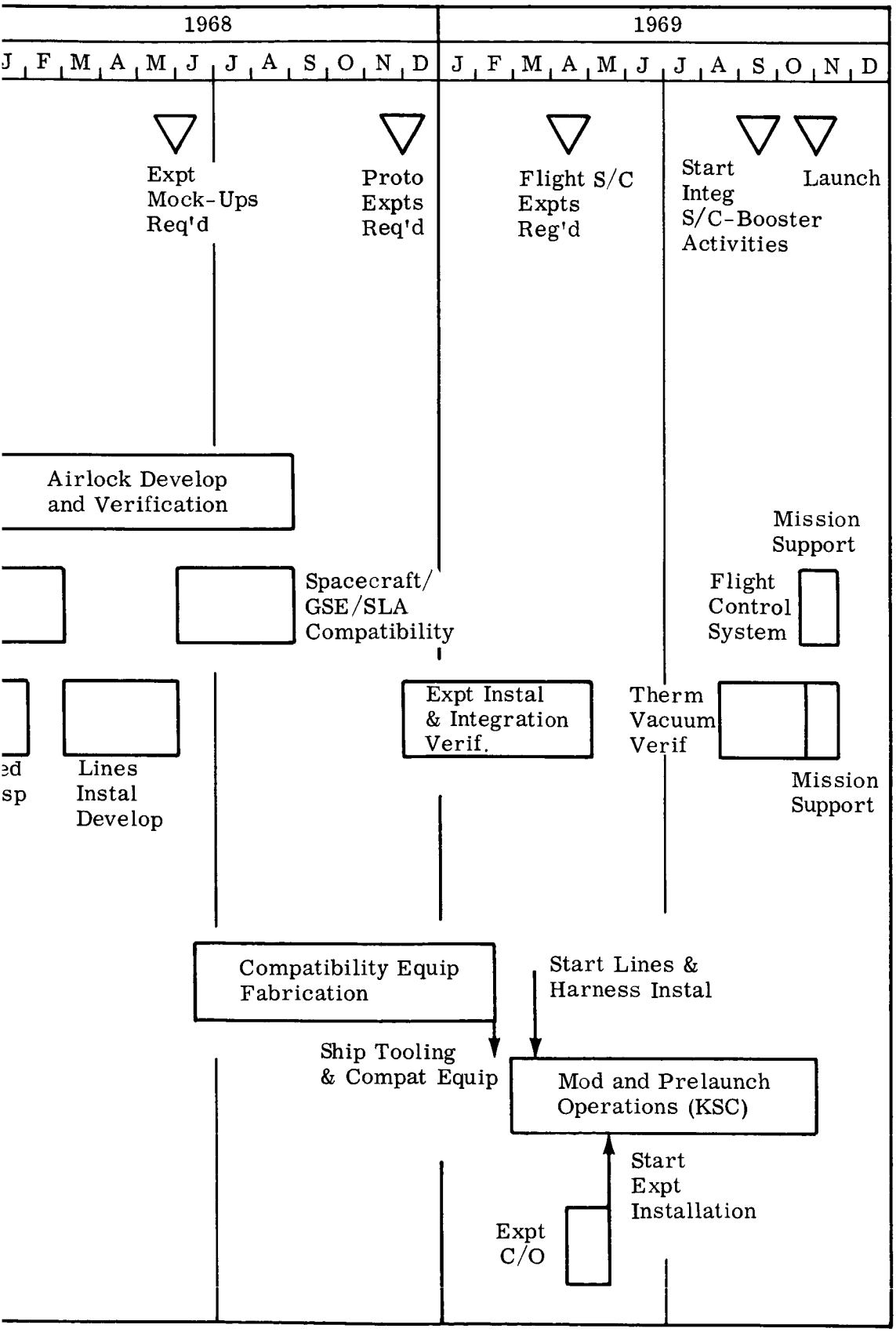
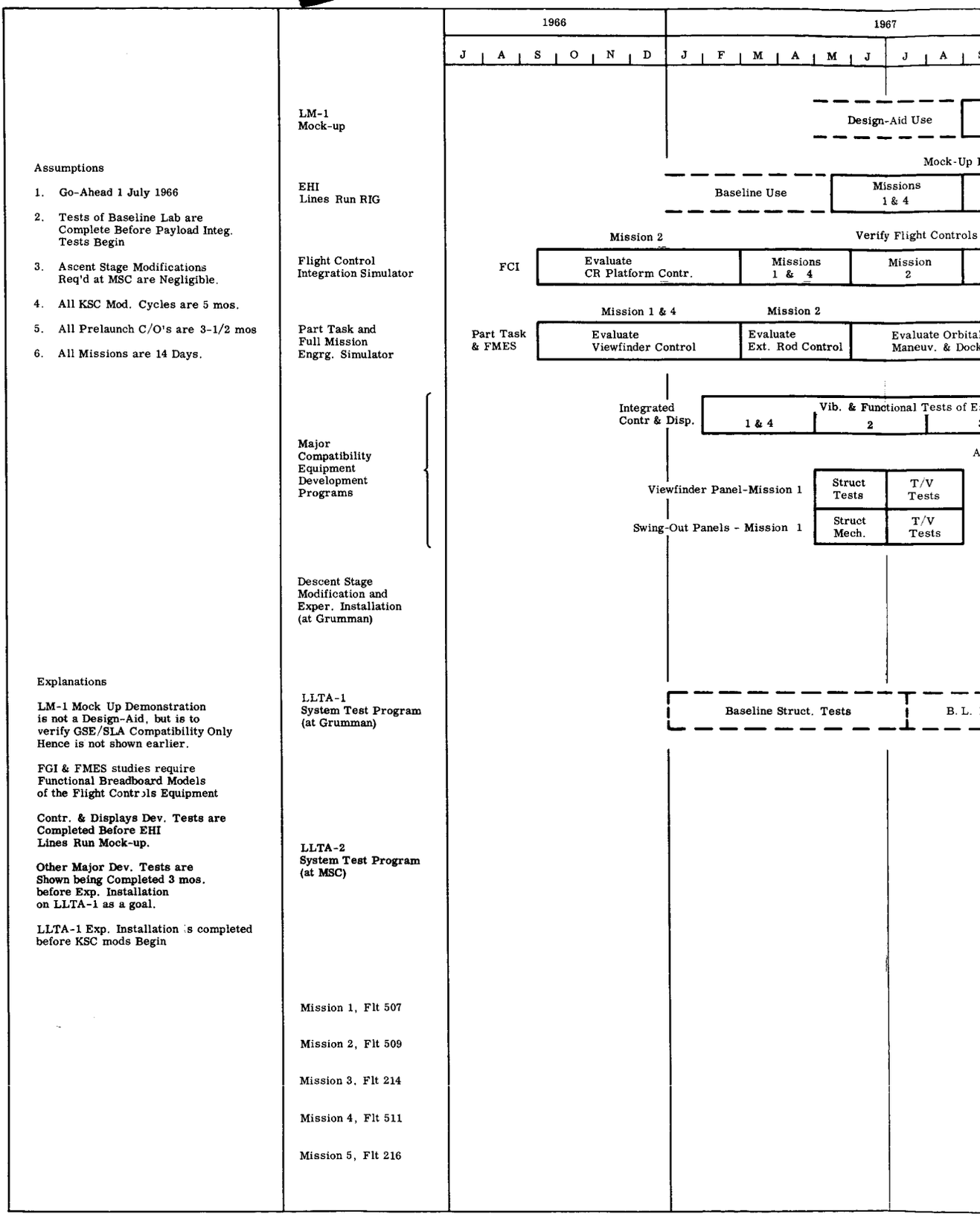


Figure 2.1-6 Flight 216 Development Schedule

Grumman



Assumptions

1. Go-Ahead 1 July 1966
2. Tests of Baseline Lab are Complete Before Payload Integ. Tests Begin
3. Ascent Stage Modifications Req'd at MSC are Negligible.
4. All KSC Mod. Cycles are 5 mos.
5. All Prelaunch C/O's are 3-1/2 mos
6. All Missions are 14 Days.

Explanations

LM-1 Mock Up Demonstration is not a Design-Aid, but is to verify GSE/SLA Compatibility Only Hence is not shown earlier.

FGI & FMES studies require Functional Breadboard Models of the Flight Controls Equipment

Contr. & Displays Dev. Tests are Completed Before EHI Lines Run Mock-up.

Other Major Dev. Tests are Shown being Completed 3 mos. before Exp. Installation on LLTA-1 as a goal.

LLTA-1 Exp. Installation is completed before KSC mods Begin

2.2.1-1

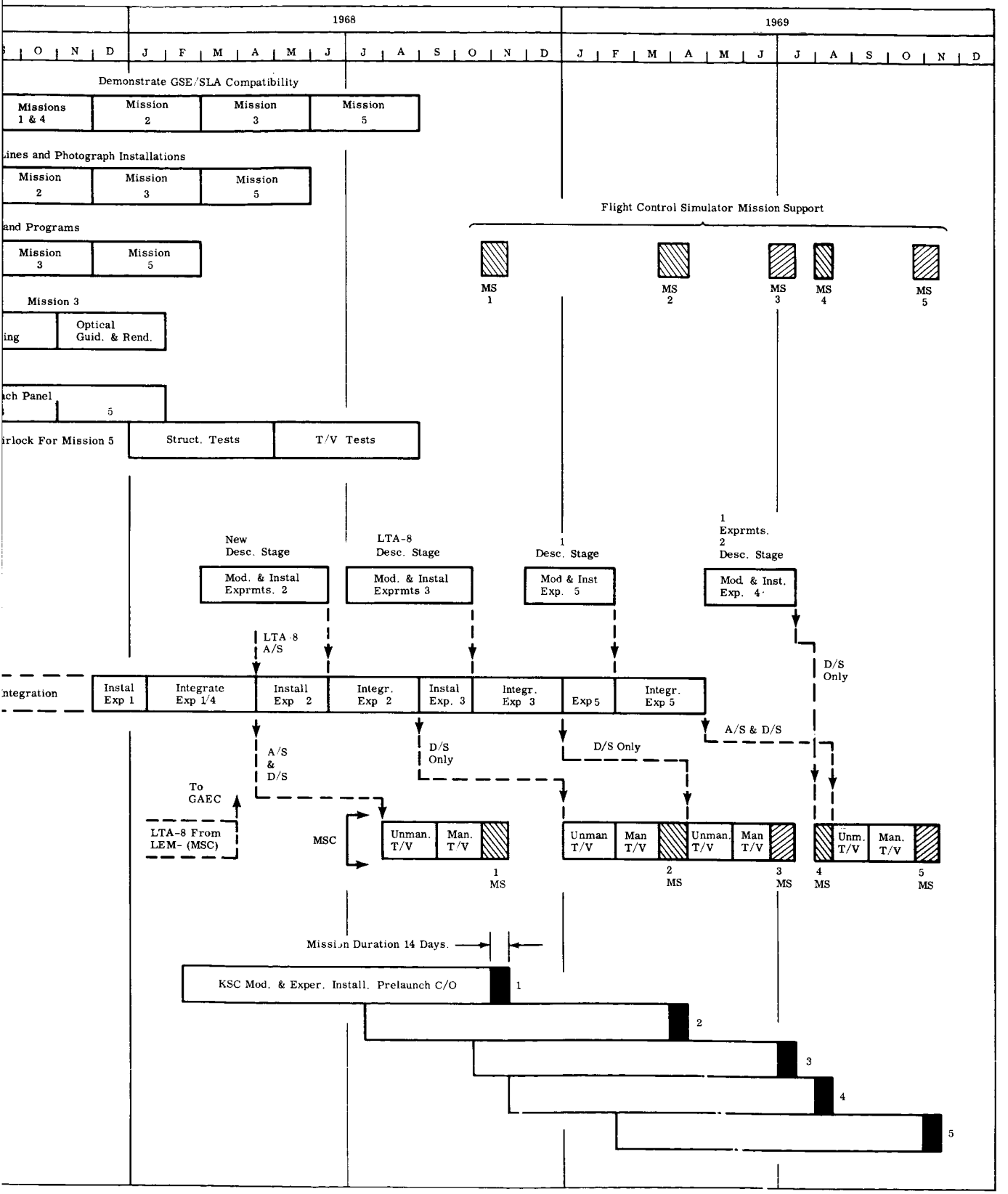


Figure 2.2-1 Phase I Lab Payload Integration Development Schedule

3. TEST PLAN

3.1 INTRODUCTION

The Section complements the Ground Development Test Plan, Volume XIX of the AES-LEM Phase B Final Report, and describes the tests required to accomplish experiment payload integration for each Phase I Lab mission. The payload integration program consists of the following categories of verification and demonstration activities:

- Compatibility equipment development and qualification tests.
- Payload integration system tests.
- Mission support.

3.2 COMPATIBILITY EQUIPMENT DEVELOPMENT AND QUALIFICATION TESTS

Tests are performed to develop and qualify the compatibility package equipment which is required to integrate the experiment payloads with the baseline LEM Lab to form an integral system. The compatibility equipment test requirements are identified in Figures 3.2-1 through 3.2-4 for Flights 507/511, 509, 214, and 216, respectively. The quantities of hardware shown in the figures are for equipment development tests at Grumman and do not include requirements for system tests, or the vendor hardware required for qualification of new designs.

The compatibility equipment tests are performed to the more critical of the Flights 507/511 mission environments, durations, and operational requirements, hence do not require repeating for Flight 511. The simulation studies identified for the GN&C Subsystem are required to evaluate the overall system performance of the viewfinder as combined with the spacecraft dynamics and the Lab's flight control system. The Flight Control Integration (FCI) can be utilized to perform closed-loop evaluations of the viewfinder related spacecraft maneuvers with the option of having man-in-the-loop as required.

The performance of the counter-rotating platform required on Flight 509 is evaluated utilizing the GN&C Subsystem test facility simulator. The platform's ability to satisfy the attitude requirements of the experiments during rotisserie phases of the mission will be demonstrated.

The Saturn IB Flight 214 contains guidance, rendezvous, and orbital maneuvering and docking experiments. The performance of the flight control system is evaluated in the Part Task Simulator, Full Mission Engineering Simulator, and the FCI Simulator, permitting man-in-the-loop demonstrations.

The performance of the GN&C Subsystem for Flight 216 is required to verify the capability of the control system during astronaut extravehicle activities and performance of the extendable rod experiments. The verification will be accomplished on the FCI Simulator.

3.3 PAYLOAD INTEGRATION SYSTEM TESTS

Payload integration tests are required to evaluate and verify the satisfactory performance of the integrated experiment payload/spacecraft system and its support equipment. These system level tests are performed for each of the four Phase I Lab configurations. The more critical of the Flights 507/511 mission environments are used to generate the system test requirements for that configuration and are not repeated for Flight 511.

3.3.1 Assumptions

It is assumed that the following items have been previously developed and satisfactorily demonstrated:

- The baseline Lab with its GSE and Operation Checkout Procedures (OCP) or the previous Lab configuration.
- The compatibility equipment with its GSE and OCP.
- The experiments and their GSE and OCP (provided as GFE).

3.3.2 Test Objectives

The purpose of the individual payload integration test programs is to evaluate and demonstrate the ability of the integrated spacecraft/experiment payload and crew to perform the particular mission. The specific test objectives are:

- Verify the modification, installation, and checkout procedures for the compatibility equipment.
- Verify the installation and checkout procedures for the experiments.
- Verify the spacecraft/experiment and GSE compatibility within the launch adapter (SLA).
- Verify the integrated system functional checkout program and demonstrate the compatibility of the Lab with the ACE-S/C and GSE.
- Evaluate the performance of the integrated system during mission-level launch vibrations.
- Evaluate the performance and demonstrate the electromagnetic compatibility (EMC) of the integrated system in the flight configuration after mission level launch vibrations.
- Verify the integrated system prelaunch functional checkout program.
- Evaluate the performance and demonstrate the manned operation of the integrated system in a simulated space environment.

3.3.3 Test Description

The payload integration system tests are performed with the following test articles in the flight configuration being developed or demonstrated:

- LM-1: Is a full-scale mock-up of the Lab, experiments, and GSE within the launch adapter. The basic mock-up is provided from the baseline Lab development program, and is used as a design-aid for experiment integration and control and display design studies. The LM-1 also demonstrates the fit and the service and maintenance accessibility of each of the LEM Lab designs in the stacked configuration.

- EHI: Is a full-scale electrical harness and lines integration rig which is used exclusively as a design-aid for preparing the lines installation drawings for each of the LEM Lab designs.
- LLTA-1: Is the test article on which the system test program will be performed at Grumman. The objective of this program is to evaluate and verify the satisfactory performance of the integrated experiment payload/spacecraft system including the required checkout procedures and GSE, prior to beginning experiment installation and system checkout activities at KSC. The program assumes demonstration of the capability of the baseline Lab to satisfactorily support all experiment payloads prior to the beginning of the payload integration test program. The payload integration tests, performed for each mission configuration, will include:

    - o Functional performance and operational checkout procedure verification with ACE-S/C and GSE
    - o Structural and functional performance verification during mission level launch vibration
    - o Function performance and electromagnetic compatibility (EMC) verification after mission level launch vibration.

- LLTA-2: Is the test article on which the system test program is performed at the MSC to evaluate and verify the satisfactory performance of the integrated experiment payload spacecraft system in the simulated space environment. These tests demonstrate the suitability of the integrated system to perform and support the crew in a thermal-vacuum (T/V) space environment. It is planned to use T/V Chamber B at MSC, with ACE-S/C and GSE. It should be noted that the LLTA-1 and LLTA-2 test programs are performed with a sequence of test articles to facilitate the reconfigurations required.

3.4 MISSION SUPPORT

Following the completion of the manned operation evaluation of each of the LEM Labs in a simulated space environment, the test article is held in operational readiness at KSC for the duration of the mission. In the event of any equipment malfunction or activity related contingency occurring in flight, the following capabilities are provided:

- Synthesis of simulation of the malfunction
- Evaluation of the degree and rate of degradation of system performance
- Diagnosis for cause of malfunction
- Development and verification of corrective procedures before initiating action on flight spacecraft.

The mission support capability is provided in a "plugs-out" test configuration, simulating the spacecraft in flight to permit synthesis and diagnosis rather than programmed checkout. Full utilization and real-time monitoring of the spacecraft's own data systems (displayed, transmitted, and stored) is required since the fault could be located in the instrumentation, or in its interpretation of operation, as well as in the equipment itself. Having the mission support capability provided at the MSC offers the option of performing space environment tests for manned life support system diagnosis, in addition to ambient functional tests.

Mission support is also provided with the FCI Simulator at Grumman. This simulator adds the capability for evaluating spacecraft control dynamics for automated flight or with man-in-the-loop.

3.5 TEST PROGRAM CONSTRAINTS

Test program constraints are those special test prerequisites which must be satisfactorily completed before beginning some other critically dependent activity. Particular emphasis and definition of the constraints are necessary since the modifications of the flight spacecraft and the installation of the experiments will be performed at the launch site rather than at the contractor's factory. The overall constraint relationship for Flights 507/511, 509, 214, and 216 are identified in the Test Constraint Logic Diagrams in Figures 3.5-1 through 3.5-4, respectively. The individual constraint milestones are described as follows:

- Completion of all development verification tests for compatibility equipment and experiments, before starting payload integration tests on the system test article.
- Completion of mock-up demonstration for compatibility of spacecraft, experiments, and GSE within the launch adapter (SLA) before starting payload integration tests on the system test article.
- Complete mechanical fit installation, fluid leakage and electrical circuit (DITMO) verification tests of the compatibility package on the test article before installation of compatibility package on flight vehicle at KSC.
- Complete mechanical fit installation and fluid leakage verification of experiments on the test aritcle before starting installation of experiments on the flight vehicle at KSC.
- Complete the verification of performance of the integrated spacecraft using the appropriate operation checkout procedures on the system test article, with GSE and ACE-S/C, before starting the functional system checkout of the flight article at KSC.
- Complete the qualification of all compatibility equipment and experiment hardware before starting mission level launch vibration with the system test article.
- Complete the verification of the performance and the electromagnetic compatibility (EMC) of the mated spacecraft following mission level launch vibrations with the system test article before final mating of the stages at KSC.
- Completion of the verification of the prelaunch checkout procedures and program using the system test article, with GSE and ACE-S/C, before starting the prelaunch checkout of the flight spacecraft at KSC.
- Complete the demonstration of the suitability of the spacecraft for manned operation in a space environment using the system test article at the MSC, before stacking at KSC. (Nominally, 6 weeks before launch).
- Complete manned simulation of the scientific missions and EVA each flight in the space environment at the MSC 1 week before launch.
- Provide and maintain complete readiness for manned space simulation tests at MSC starting 1 week before launch for mission support.
- Provide and maintain complete readiness for flight control system simulation at Grumman starting 1 week before launch for mission support.

It should be noted that only the last two constraints must be satisfied for Flight 511, as shown in the Test Constraint Logic Diagram, Figure 3.5-1.

FLIGHTS 507/511 COMPATIBILITY EQUIPMENT DEVELOPMENT TESTS

Supported Subsystem	Compatibility Item	Development Program	Test Quantities	Test Facilities
Structures & Mechanical Devices	Swing-Out Panels (2) • Active Cooling • Passive Cooling	Strength, Stiffness, Deployment, Thermal Control Properties	2 ea	Structures Lab, Thermal/Vacuum Chamber
	Battery Support Structures	Strength, Stiffness Thermal Control	1 ea type	Structures Lab, Thermal/Vacuum Chamber
	Lunar Surface Probe Supports	Strength, Stiffness Deployment/jettison	2 ea type	Structures Lab
	Viewfinder Installation	Strength, Leakage	1 panel	Structures Lab, Cold-Flow Facility, (Use LEM Window Test Rig)
	Experiment Support Racks (5) • Aft Bay • Lower Section Adapter • IR Telescope • RF Antenna • ERA Side Mount	Strength, Stiffness	1 ea	Structures Lab
ECS	Two Active Systems • ERA Side Mount • Swing-Out Panel	Balance Cooling Fluid Flows	1 ea	Liquid Test Rig (LTR)
	Cabin Life Support System	Investigate Combined LAB/CSM Effects	2	Modified LEM Internal Environment Simulator (IES) for 14-Day Mission, Oxygen Supply Simulator (OSS)
EPS	Additional Batteries & ECA's	Power Distribution & Control	1	Baseline EPS Facility

Figure 3.2-1. Flights 507/511 Compatibility Equipment Development Test (Sheet 1 of 2)

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FLIGHTS 507/511 COMPATIBILITY EQUIPMENT DEVELOPMENT TESTS (CONT)

Supported Subsystem	Compatibility Item	Development Program	Test Quantities	Test Facilities
GN&C	Horizon Sensor	Use Available Qualified Models	----	----
Instrumentation	Photo Timing Reference	Use Qualified Hardware	----	----
Controls & Displays	Cartographic Camera Stellar Camera Video Display Unit	Use Available Qualified Units	----	----
	Integrated Control & Display panels for experiments	Feasibility thru Qualified Model	1 ea panel	Environmental Test Lab
	Interface with viewfinder	Vehicle Dynamics Functional Interface	As req'd for Simulators	Part Task Simulator, Full Mission Engineering Simulator (FMES)
Communications	Uses Qualified Hardware	Antenna Location Studies	1 ea Type Antenna	Antenna Model Range
Crew Provisions	Uses Qualified Hardware	----	----	----
RCS	Uses Qualified Hardware	----	----	----

Figure 3.2-1. Flights 507/511 Compatibility Equipment Development Test (Sheet 2 of 2)

Grumman

FLIGHT 509 COMPATIBILITY EQUIPMENT DEVELOPEMENT TESTS

Supporting Subsystem	Compatibility Item	Development Program	Test Quantities	Test Facilities
Structure & Mechanical Devices	Counterrotation Platform Supporting Structure	Strength & Stiffness, Dynamic Response	1	Structures Lab
	SMS Boom Support	Strength & Stiffness	1 ea	Structures Lab
	SMS Rack (3)	Strength & Stiffness	1 ea	Structures Lab
	Equipment Support Racks (4) • Left Side • Right Side • Stem Rod Experiment • Side ERA Rack	Strength & Stiffness	1 ea	Structures Lab
ECS	Active Cooling Loop for Counterrotation Platform	Adopt Qualified Items Verify Performance	1	Liquid Test Rige (LTR)
GN&C	Counterrotation Platform	Performance Verification	As req'd for simulation	Rate Table in FCI Lab
	LEM Rendezvous Radar			
	Stellar Camera	Use Qualified Models	----	----------
	Television Camera			
Instrumentation	Signal Conditioner	Adopt qualified items Verify Performance	1	Instrument Development Lab

Figure 3.2-2. Flight 509 Compatibility Equipment Development Tests (Sheet 1 of 2)

Grumman

FLIGHT 509 COMPATIBILITY EQUIPMENT DEVELOPMENT TESTS (CONT)

Supporting Subsystem	Compatibility Item	Development Program	Test Quantities	Test Facilities
Communications	SMS Communications • Transceiver • Omni-antennas • Signal Processor • Diplexer	Modify Existing Equipment Antenna Location Model Studies	1 ea with antenna	Antenna Model Range
Controls & Displays	Time Lapse Camera Integrated Control & Display Panels for experiments	Use Qualified Model Development through Qualified Model	-------- 1 ea	---------- Environmental Test (Vibration)
EPS	Additional Batteries & ERA	Integrate into Baseline EPS	1	EPS Facility
Crew Provisions	Uses Qualified Hardware	----------	-------	----------
RCS	Uses Qualified Hardware	----------	-------	----------

Figure 3.2-2. Flight 509 Compatibility Equipment Development Tests (Sheet 2 of 2)

Grumman

FLIGHT 214 COMPATIBILITY EQUIPMENT DEVELOPMENT TESTS

Supporting Subsystem	Compatibility Item	Development Program	Tests Quantities	Test Facilities
Structural & Mechanical Devices	ERA Rack - Left Side	Strength Stiffness	1	Structures Lab
	Battery Support Structures (38 batteries, descent)	Strength, Stiffness	1 (typical instal)	Structures Lab
	Experiment Support Structs. (6) • GOX, H_2O, & Capture Device • Control Moment Gyro • Laser Transceiver • SMS & ECHO • Navigation Sensors • Propellant Handling	Strength, Stiffness	1 ea	Structures Lab
ECS	Active Cooling Systems(2)			
	GOX Tanks	Use Qualified Models	1 ea	OSS, LTR
	H_2O Tanks	Integrate into Systems		
EPS	Batteries & ERA (38 Batteries,descent)	Use qualified Models Integrate into EPS	1	EPS Facility
GN&C	LEM Rendezvous Radar & Antenna			
	LEM Program Coupler Assy	No requirement for test, since same installation as LEM	--------	----------
	LEM Guidance Computer			
	LEM Inertial Measuring Unit			

Figure 3.2-3 Flight 214 Compatibility Equipment Development Tests (Sheet 1 of 2)

Grumman

FLIGHT 214 COMPATIBILITY EQUIPMENT DEVELOPEMENT TESTS (CONT)

Supporting Subsystem	Compatibility Item	Development Program	Tests Quantities	Test Facilities
GN&C (Cont.)	LEM Power & Servo Assy LEM Pulse Torquer Assy LEM Coupling Data Unit	No requirement for test since same installation for LEM	-------	----------
Instrumentation	Signal Conditioner Photo Timing Reference	Use Qualified Models	-------	----------
Communication	R & D Transmitter Decoder Command Assy SMS Transceiver Omni Antennae Signal Processor Diplexer	Use Qualified Models	-------	----------
Controls & Displays	16-mm Movie Camera TV Monitor Integrated Controls & Displays for Experiments	Use Qualified Models Development through Qualified Models	1 ea	Environmental Test Lab (Vibration)
Crew Provisions	Additional Food, LiOH	Use Qualified Models	-------	----------
Propulsion	Separation Device	Vendor	-------	----------

Figure 3.2-3. Flight 214 Compatibility Equipment Development Tests (Sheet 2 of 2)

Grumman

FLIGHT 216 COMPATIBILITY EQUIPMENT DEVELOPMENT TESTS

Supporting Subsystems	Compatibility Item	Development Program	Tests Quantities	Test Facilities
Structures and Mechanical Devices	Descent Stage Airlock	Strength, Stiffness Mechanical Operation Leakage, Temp Control	2	Structure Lab, Cold Flow Facility, Hydrostatic Facility Thermal/Vacuum Chamber
	Experiment Support structure • Quadrant I • Quadrant IV • Lower Section	Strength, Stiffness	1 ea	Structures Lab
	Expendables Storage Racks • Aft Bay • Left Side • Right Side	Strength, Stiffness	1 ea	Structure Lab
	ERA Racks (2) • Left Side • Right Side	Strength, Stiffness	1 ea	Structures Lab
	Battery and ERA Racks (30 Desc 20 Asc)	Strength, Stiffness	1 ea	Structures Lab
	Stern Rod Experiment Support	Strength, Stiffness	1 ea	------
ECS	GOX Tanks (7) H_2O Tanks Descent Stage Airlock	Verify Tanks and Airlock	1 assy ea	Baseline ECS including: Internal Environment simulator (IES), Oxygen Supply Simulator (OSS), Water Management System (WMS), and Liquid Test Rig (LTR).

Figure 3.2-4. Flight 216 Compatibility Equipment Development Tests (Sheet 1 of 2)

Grumman

FLIGHT 216 COMPATIBILITY EQUIPMENT DEVELOPMENT TESTS (CONT)

Supporting Subsystems	Compatibility Item	Development Program	Tests Quantities	Test Facilities
EPS	Additional Batteries & ERA (30 Asc, 20 desc)	Integrate Batteries Use Qualified Models	1	EPS Facility
GN&C	Program Coupler Assembly	Use Qualified Models	-	-
Instrumentation	Signal Conditioner	Use Qualified Models	-	-
Communications	R & D Transmitter Decoder Command Assembly	Use Qualified Models	-	-
Controls & Displays	16-mm Movie Camera 20-mm Frame Camera 20-mm Time Lapse Camera TV Camera & Tilt Table TV Monitor	Use Qualified Model	-	-
	Integrated Controls & Display for Experiments	Development, thru Qualified Models	1 ea	Environmental Lab (Vibration)
Crew Provisions	Additional Food, LiOH	Use Qualified Models	-	-
Propulsion	Separation Device	Vendor	-	-

Figure 3.2-4. Flight 216 Compatibility Equipment Development Tests (Sheet 2 of 2)

Grumman

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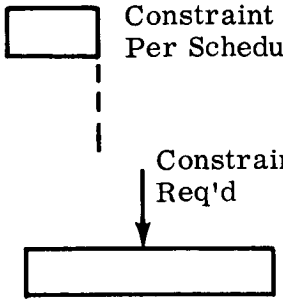
Symbols



Test Constraint Legend

1. Complete Equipment Development Verification Tests.
2. Demonstrate Lab/GSE/SLA Compatibility
3. Install and Verify Compatibility Equip.
4. Install Experiments.
5. Verify Functional Checkout Procedures
6. Complete Equipment Qualification Tests
7. Mission Level Mated Vibration Test
8. EMC Demonstration
9. Verify Prelaunch Checkout Procedure
10. T/V Demonstration at MSC
11. Manned T/V Mission Simulation at the MSC.
12. Mission Support at MSC
13. Mission Support with FCI.

	1966 J	A	S	O	N	D	J	F	M	A	M	J
Flight Control System and Mission Simulation							Part Task and Full Mission Sim					FC
Development Programs							Compatibility Equip. & Exper.					De
LM-1 Mock-up												
(LLTA 1) Payload Integration Program at Grumman												
(LLTA-2) System Thermal Vacuum Demo. And Mission Support at the MSC												
KSC Program Modif, Checkout and Launch												Strip Mod.

[redacted]

3.5-1-1

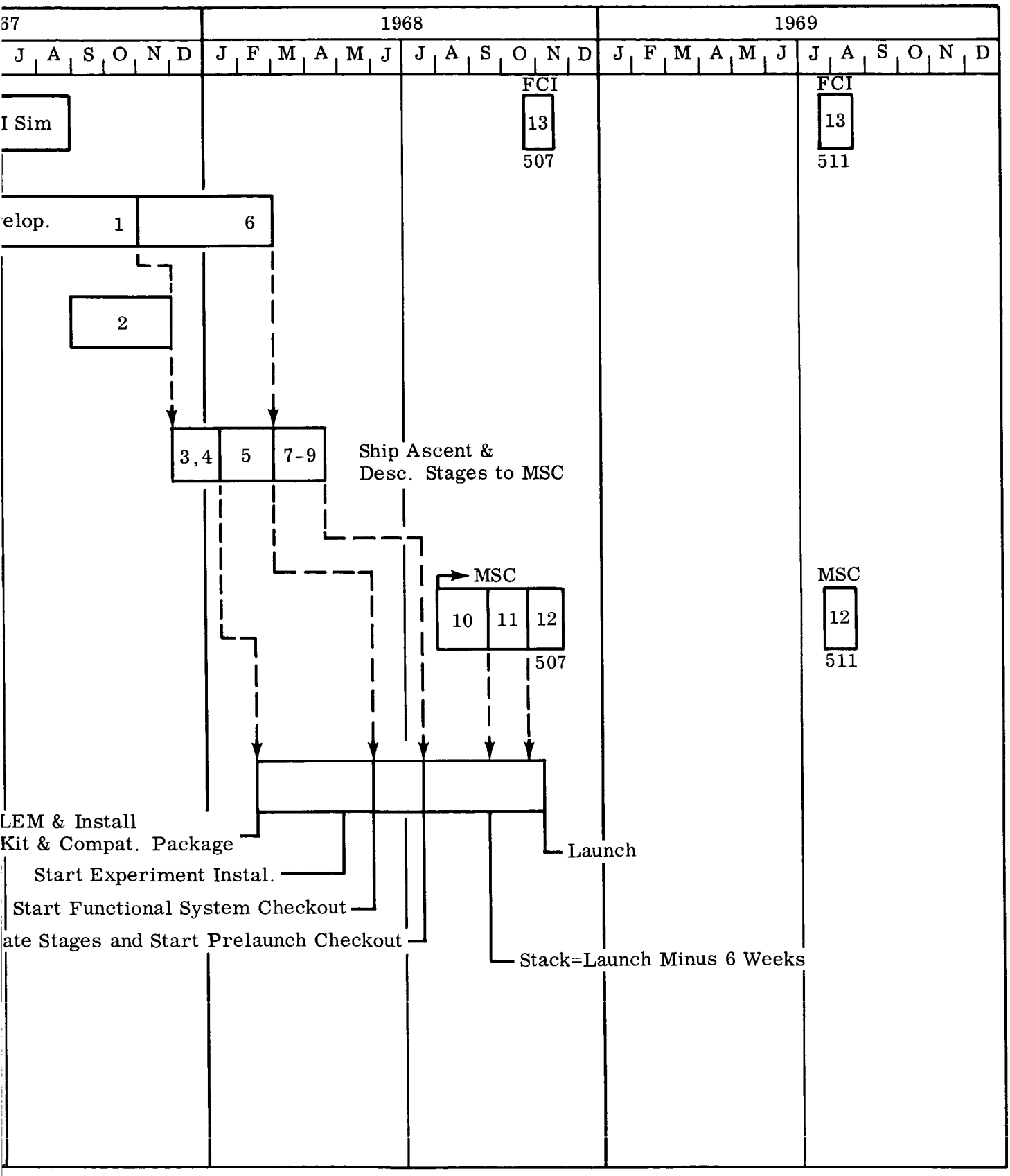


Figure 3.5-1 Flights 507/511 Test Constraint Logic Diagram

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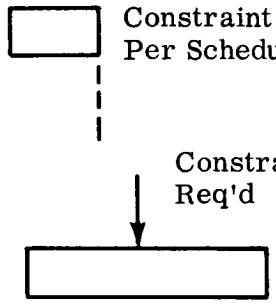
Symbols



Test Constraint Legend

1. Complete Equipment Development Verification Tests.
2. Demonstrate Lab/GSE/SLA Compatibility.
3. Install and Verify Compatibility Equip.
4. Install Experiments.
5. Verify Functional Checkout Procedures (OCP)
6. Complete Equipment Qualification Tests
7. Mission Level Mated Vibration Test
8. EMC Demonstration
9. Verify Prelaunch Checkout Procedure
10. T/V Demonstration at MSC
11. Manned T/V Mission Simulation at the MSC.
12. Mission Support at MSC
13. Mission Support with FCI.

	1966						196					
	J	A	S	O	N	D	J	F	M	A	M	J
Flight Control System Simulator												
Development Programs							Compatibility Equip. &					
LM-1 Mock-up												
(LLTA-1) Payload Integration Program at Grumman												
(LLTA-2) System Thermal Vacuum Demo. and Mission Support at the MSC.												
KSC Program Modif., Checkout and Launch												

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3.5-2

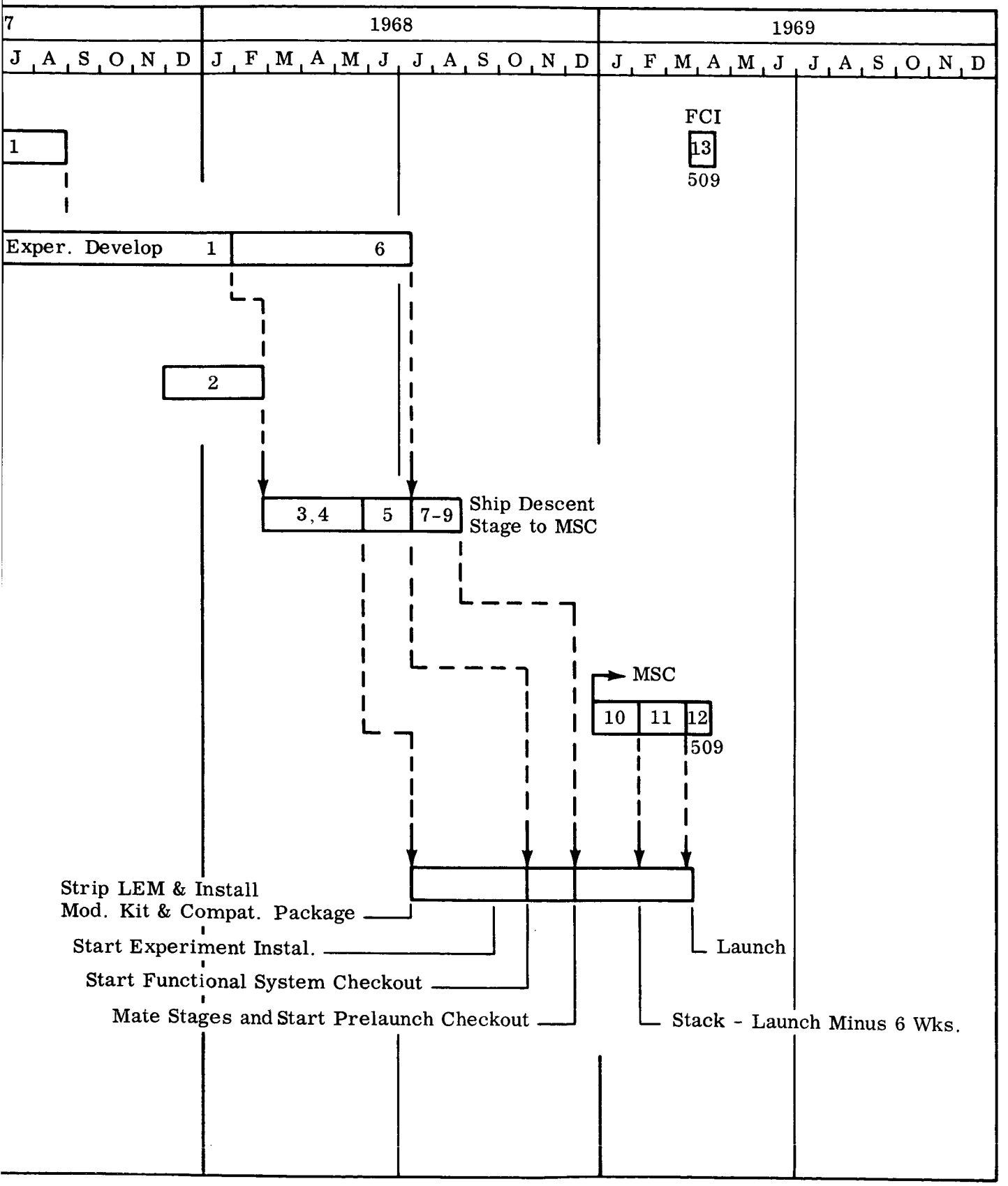

Figure 3.5-2 Flight 509 Test Constraint Logic Diagram

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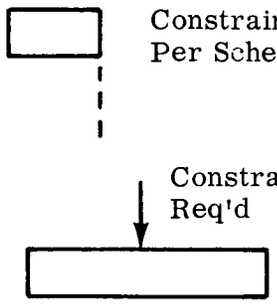
Grumman

Symbols



Test Constraint Legend

1. Complete Equipment Development Verification Tests.
2. Demonstrate Lab/GSE/SLA Compatibility.
3. Install and Verify Compatibility Equip.
4. Install Experiments.
5. Verify Functional Checkout Procedures (OCP)
6. Complete Equipment Qualification Tests
7. Mission Level Mated Vibration Test
8. EMC Demonstration
9. Verify Prelaunch Checkout Procedure
10. T/V Demonstration at MSC
11. Manned T/V Mission Simulation at the MSC.
12. Mission Support at MSC
13. Mission Support with FCI.

	1966						1967						
	J	A	S	O	N	D	J	F	M	A	M	J	J
Flight Control System and Mission Simulators													
Development Programs							Compatibility Equip. &						
LM-1 Mock-Up													
(LLTA-1) Payload Integration Program at Grumman													
(LLTA-2) System Thermal Vacuum Demo. And Mission Support at the MSC													
KSC Program Modif., Checkout and Launch													

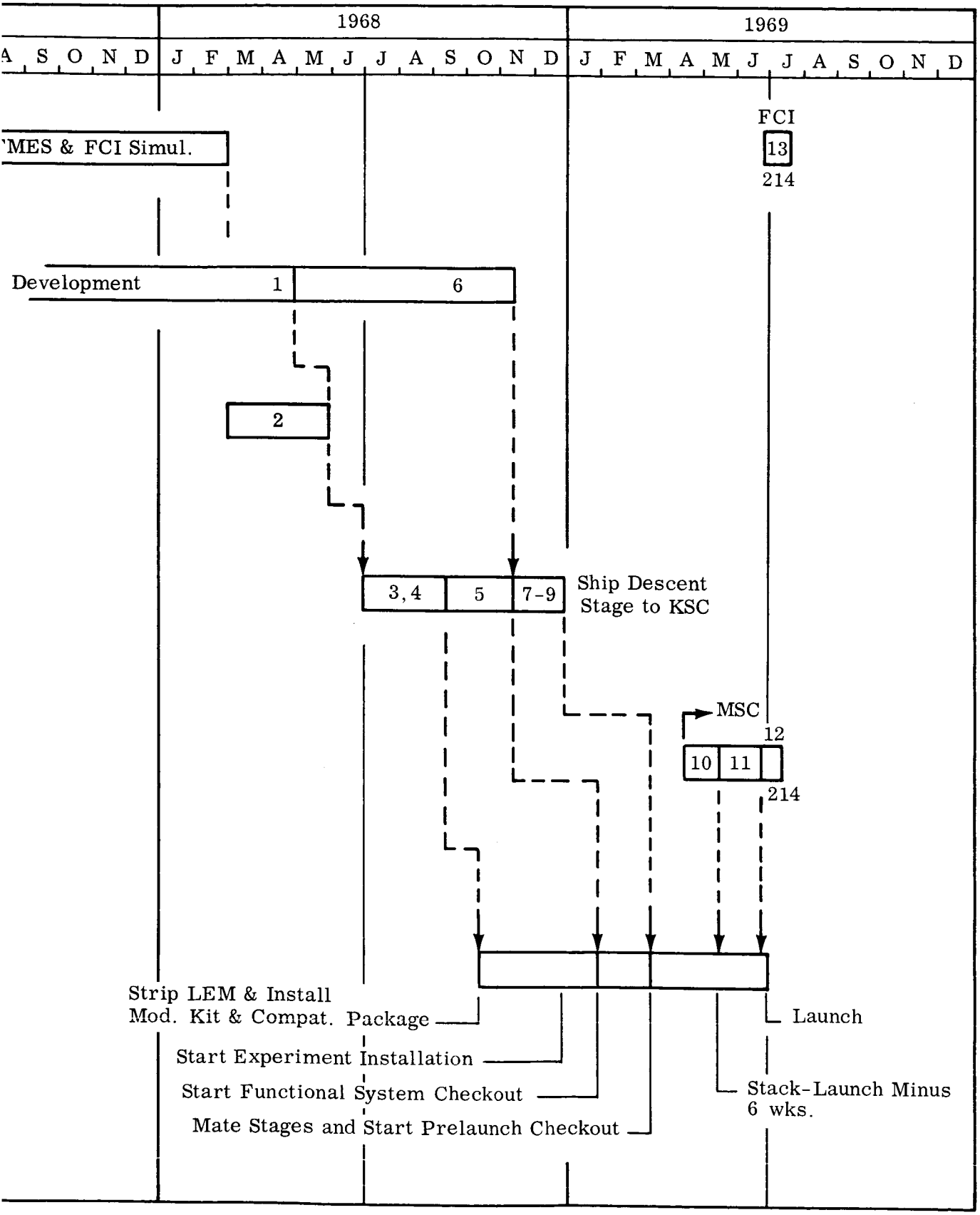


Figure 3.5-3 Flight 214 Test Constraint Logic Diagram

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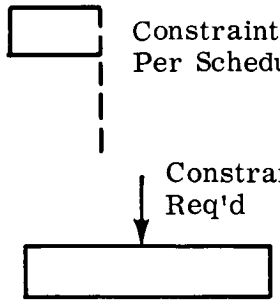
Symbols



Test Constraint Legend

1. Complete Equipment Development Verification Tests.
2. Demonstrate Lab/GSE/SLA Compatibility
3. Install and Verify Compatibility Equip.
4. Install Experiments.
5. Verify Functional Checkout Procedures (OCP)
6. Complete Equipment Qualification Tests
7. Mission Level Mated Vibration Test
8. EMC Demonstration
9. Verify Prelaunch Checkout Procedure
10. T/V Demonstration at MSC
11. Manned T/V Mission Simulation at the MSC.
12. Mission Support at MSC
13. Mission Support with FCI.

	1966						1967					
	J	A	S	O	N	D	J	F	M	A	M	J
Flight Control System Simulator (FCI)												
Development Programs												
LM-1 Mock-Up												
(LLTA-1) Payload Integration Program at Grumman												
(LLTA-2) System Thermal Vacuum Demo. and Mission Support at the MSC												
KSC Program Modif, Checkout, and Launch												

Compatibility Equip.

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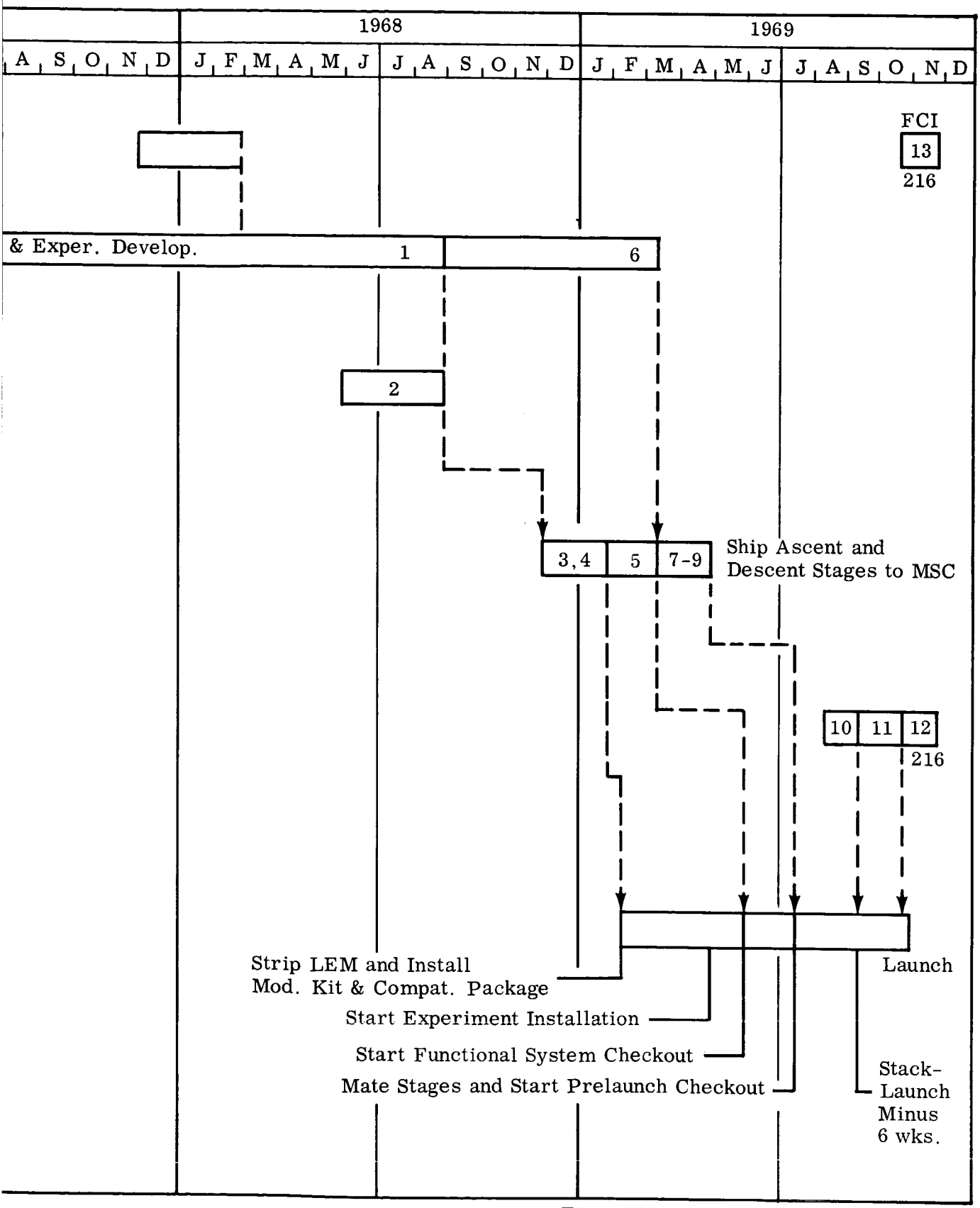

Figure 3.5-4 Flight 216 Test Constraint Logic Diagram

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Grumman

4. MANUFACTURING PLAN

4.1 INTRODUCTION

This Section presents the results of the Phase B Addendum Study of payload integration manufacturing tasks associated with the Apollo Extension System (AES) Phase I Laboratories. The following ground rules form the basis for the Payload Integration Manufacturing Plan.

- Schedule compatibility with launch dates shown in Flight Mission Assignment Plan for AES Planning, ML 65-1, dated 7 August 1965.
- LEM/AES Integrated Manufacturing Schedule, Volume XVII, Manufacturing Plan Phase B Final Report
- Spacecraft manufactured to LEM configuration at Grumman (Bethpage), modified and integrated at KSC.
- Installation of experiments place the burden of accommodation upon the compatibility package, rather than the baseline vehicle.

During the course of this study it became apparent that the ground rule requiring modification of Lunar Landing LEM's to Lab configurations at KSC, imposed restrictions on schedules and facilities. A complete review of this concept indicates that modifying the LEM's at Bethpage does not substantially improve the situation, it merely shifts the facilities burden from KSC to Bethpage. A preliminary analysis of the manufacturing considerations affected by the method of arriving at a Phase I Lab configuration indicates many advantages to manufacturing each Lab directly to the flight configuration during the initial production sequence. It is therefore recommended that a detailed study of the advantages and disadvantages of building the Phase I Labs as in-house production vehicles be made prior to the Final Definition Phase. The primary advantages of building directly to the flight configuration can be summarized as follows:

- Schedule: LEM Program requirements can be completed before the first AES vehicle; therefore the Lab start date can be 4-1/2 to 7 months later than the AES/LEM Integrated Schedule proposed in Phase B.
- Facilities: The 8 vehicles per year rate is not exceeded; therefore, no major facilities will be required at Bethpage or at KSC for modification of LEM's.
- Cost: The labor cost to install and remove LEM systems not required on Labs will be eliminated.
- GSE: Duplicate modification equipment will not be required at KSC.
- Design Improvement: Greater design flexibility and additional volume will be available if systems, fluid lines, and wiring not used for Lab mission is not installed (e.g., D/S propulsion tankage).

4.2 MANUFACTURING

4.2.1 Description

The integration of the experiment payloads and compatibility packages with the baseline laboratory spacecraft will be accomplished at KSC in combination with the

modification, verification, and prelaunch operations described in Volume XVII of the Phase B Report. This method of integrating the compatibility packages and experimental payload during the modification period minimizes the requirements for facilities and optimizes the schedule without compromising quality and reliability of the spacecraft.

The compatibility packages, consisting of structural assemblies and experiment supporting subsystems, will be fabricated and assembled at Bethpage. Prior to shipment, these items will be mechanically installed on the Manufacturing Mockup at Bethpage to insure the mechanical interfacing of the compatibility packages and the baseline laboratory. These packages will be shipped from Bethpage in the highest level of complete assembly possible to eliminate reassembly and duplicate tooling requirements at the Modification Center.

During the installation of the baseline Lab modification kits, the fluid lines, electrical harnesses, experiment supporting structures, and compatibility package subsystems will be installed on a non-interference basis.

Throughout the modification sequence the work accomplished will be mounted and checked using GSE and ACE-S/C. On completion of the modification, the baseline subsystems and the compatibility packages will be verified prior to experiment hook-up to insure compatibility of the experiment electrical interfaces. To eliminate redundant testing between manufacturing and prelaunch operations, the complete flight vehicle systems tests will be accomplished during the prelaunch operations sequence.

The manufacturing tasks and schedules are predicated on the following basic design goals:

- One or more electrical junction boxes will be provided for centralization of external experiment and support systems penetration of pressure shell.
- All compatibility packages will be pre-assembled and verified at Bethpage prior to shipment to KSC to minimize final installation effort.
- Reaction Control Subsystem will not be altered.
- Environmental Control Subsystem will have only minor modifications and will require only gross leak testing.
- New electrical harnesses will be fabricated and verified at Bethpage and delivered to KSC for installation.
- All experiment packages requiring optical alignment will receive preliminary alignment with installation tooling; final alignment will be accomplished during prelaunch checkout.
- Installation of baseline Lab modification kits and experiment compatibility packages will be accomplished in parallel to provide maximum manpower and facility utilization.

Figures 4.2-1 through 4.2-4 illustrate the Phase I Laboratory buildup and approximate location of the experiment packages in the Ascent and Descent Stages. The baseline laboratory systems and components have been omitted for clarity.

4.2.2 Trade-Off Studies

4.2.2.1 Alternate Cases

An analysis of the facilities requirements for modifying LEM vehicles at KSC and at Bethpage was conducted during the study. The results of this analysis indicated a third possibility, namely, manufacturing the Lab spacecraft to the flight configuration in-line at Bethpage. The three alternate cases are:

- Case I: A LEM capable of performing the lunar landing mission is shipped to KSC for modification and installation of the required systems and experiments.
- Case II: A LEM capable of performing the lunar landing mission is modified at Grumman (Bethpage) before shipment to KSC for launch.
- Case III: The modifications and installation of systems required by AES missions are installed during the structural buildup and final assembly of the spacecraft at Grumman (Bethpage).

To limit the number variables, the following assumptions were used as guidelines:

- The present LEM final assembly and factory checkout facility cannot support additional vehicle loading in excess of the proposed LEM/AES Integrated Manufacturing Schedule.
- All LEM spacecraft to be modified in Case I and Case II are fully qualified flight articles in storage at the time of decision to convert to AES LEM's.
- Schedules for conversion of LEM to AES vehicles are based upon requirements of ML-65-1.
- The manufacturing tasks for Case I and Case II are considered as requiring approximately the same span for completion; therefore, the modification schedules apply for both.
- The access areas surrounding the modification workstands must be larger than those planned for LEM to accommodate external experiments and additional support equipment.

4.2.2.2 Schedules

Utilizing AES Flight 507 as a typical flight, a schedule for modification, installation, and verification of required systems was prepared to develop the Master Modification Schedule. This schedule delineates the time periods of individual modifications of the spacecraft for either Case I or Case II that are required to meet the launch dates as specified in ML-65-1.

The LEM/AES Integrated Manufacturing Schedule provided the Case I and Case II modification periods, the actual location of the conversion having no effect upon the requirement to initiate AES vehicles between LEM 7 and 8. Case III allows the completion of all 11 LEM vehicles before the first AES Spacecraft is ready for shipment to KSC for pre-launch checkout. Therefore, the AES vehicles can be initiated 5 months later than in CASE I or Case II.

The following tabulation lists the schedule variances for the alternate cases.

Flight	Start Date for AES Cases I&II	Start Date for AES Case III	Variance (Months)
507	4/1/67	9/1/67	5
509	7/15/67	1/15/67	6
214	9/15/67	4/15/68	7
511	11/15/67	5/1/68	5-1/2
216	3/1/68	7/15/68	4-1/2

For Flight 507, the 5-month variance does not reflect test article requirements. The manufacturing cycle for Case III would be approximately the equivalent of LEM 11, as additions and deletions of system/subsystem requirement tradeoffs are equal.

The manufacturing rate of basic spacecraft for all three cases is the same with the differences being the allocation of AES missions to earlier production positions in Cases I and II. In Case III, the AES missions are assigned to later production positions.

4.2.2.3 Facilities

The present LEM final assembly and checkout facility is capable of manufacturing 8 LEM Spacecraft per year. This requires approximately a 90% work station utilization rate. Modification of completed LEM vehicles cannot be absorbed by the present Bethpage facility; therefore, additional facilities would have to be provided for either Case I or Case II programs to support the modification efforts. Case III would not require additional facilities, as the modification effort is integrated into the baseline manufacturing cycle.

The following is a summary of facility requirements:

Case	Additional Work Stations Required	Additional Floor Space Required (Sq Ft)
I	11 (At KSC)	28,200
II	7 (At Bethpage)	19,000
III	0	0

Case I does not involve additional Bethpage facilities as these requirements would be the responsibility of NASA at the launch site, but the Case II requirements must be accomplished at Grumman. The workstation and floor space requirements at Bethpage are less than those at KSC due to the availability of certain specialized LEM workstations that have a low-utilization rate and can be phased into the modification program. Approximately 50% of the floor space requirements must be high-bay controlled environment (CEF) area.

4.2.2.4 Cost

The manufacturing costs of Cases I and II will be approximately equal discounting relocation, training, and regional pay scales. Case I will require duplication of some installation tooling and checking devices due to schedule restrictions. In Cases II and III, the tooling need not be duplicated as it will be available for both the development and production efforts.

The system/subsystem components that are to be removed and are considered as reusable can be allocated for installation in one LEM Spacecraft only (LEM 9), with the remainder being utilized for Taxi/Shelter missions.

Typical Case I and Case II system/subsystem equipment allocation is as follows:

AES Flight	Equipment Available From Stripped Vehicle	Allocated To:	Storage Time Prior To Reinstall. (Months)	Total Storage Time Prior To Reinstall. (Months)
507	3/1/68	LEM 9	3	14
509	8/1/68	Shelter 514	8	19
214	11/1/68	Taxi 515	5	17
511	12/1/68	Shelter 519	13	26
216	3/1/69	Taxi 520	13	24

Cases I and II involve the use of components having accumulated storage times from 1 to 2 years, assuming that all removed equipment would be used on the subsequent flights.

Case III would eliminate the following major cost items:

- Initial installation and checkout of components not required for mission configuration.
- Removal and preservation of the individual components not required for mission configuration.
- Structural modification kits required to accommodate new and/or altered components.

4.3 SCHEDULES

4.3.1 Master Manufacturing Schedule

The schedule for modification and checkout of Phase I Lab at KSC (Figure 4.3-1) represents the time phasing required to convert a LEM to an integrated Phase I Lab and the contributing manufacturing activities to perform the payload integration function. The schedule is based on the availability and allocation of LEM, as described in Volume XVII, Manufacturing Plan, Phase B Final Report.

In accordance with the study guidelines, vehicle modification and integration will be performed at KSC based on a "bolt-on/plug-in" approach to all modification kits

and compatibility packages as well as experiments. The modification kits and compatibility packages will be fabricated at Grumman (Bethpage). Experiments are government furnished.

4.3.2 Development Schedule

The vehicle modification and integration schedule encompasses four major activities:

- Conversion of the LEM vehicle to a "baseline" Phase I Lab
- Installation of compatibility packages.
- Installation of the experiment equipment.
- Verification of manufacturing operations prior to pre-launch

For economy of operation, these activities will be performed in parallel, with the specific operations of each performed at the optimum point in the over-all cycle. This will eliminate the repetitive factory tests (i.e., leak checks and continuity tests) and movement of the vehicle in and out of "controlled environment" areas.

The vehicle modification and integration schedule spans 15-1/2 weeks as compared to an 18-week span described in Volume XVII, Phase B Final Report. The contraction of the cycle is the result of a vehicle flow analysis which minimizes vehicle movements and a re-definition of test functions to prevent duplication of operations. The major improvements affected are:

- Deferment of the alignment, weigh and cg operations to a later point in the pre-launch checkout cycle.
- Combination of the leakage and functional tests, previously performed during pre-launch checkout, with the proof-pressure check required in the manufacturing cycle.
- Delegation of all quantitative functional testing to the pre-launch checkout operations with final assembly reduced to a quantitative nature.
- Deferment of physical vehicle stage mating to the pre-launch checkout cycle.

Evaluation of existing design data indicates that the variation of the modification and integration schedule from flight to flight will be insignificant. Therefore, Figure 4.3-1 represents the"typical" modification and integration cycle.

4.4 TYPICAL FLIGHT TASK DESCRIPTION

4.4.1 Structure

The manufacturing task for integrating each Phase I Lab flight configuration has been analyzed. The results of this analysis suggest the presentation of a "typical flight" task description. AES Flights 507/511 have been selected as the typical flights for this presentation.

4.4.1.1 Unpack Ascent and Descent Stages

- Remove each stage from its transporter, transfer the stages to the stripping area and install each stage in its workstand.
- Remove all protective covers and visually inspect each stage for shipping damage.

4.4.1.2 Strip Ascent and Descent Stages

Perform the following operations in accordance with subparagraphs 5.2.1.2 and 5.2.1.3 of Volume XVII, Manufacturing Plan, AES-LEM, Phase B Final Report.

- Remove all thermal shielding
- Remove all unnecessary equipment
- Plug and seal all open fluid lines
- Pot and clamp all free connectors

4.4.1.3 Install Structure for Modification Kits and Compatibility Packages in Ascent Stage.

4.4.1.3.1 Mid Section and Cabin Section, Interior. Install all baseline AES Phase I Lab structural modification kits in accordance with Volume XVII, Manufacturing Plan, AES-LEM, Phase B Final Report. The sequence of equipment installation is as follows:

- Pulse Converter structure (3J), (Figure 4.2-1).
- Battery Charger structure (4F)
- Format Converter structure (11L)
- Kalvar Recorder structure (11M)
- Tape Recorder structure (13E)
- Gradiometer structure (14G)
- "P" Circuit Breaker Panel structure
- Panel 4, 8, and 10 structure

4.4.1.3.2 Forward Section, Exterior.

- All Baseline AES Phase I Lab structural modification kits
- Viewfinder structure (8C)
- Omni Directional Scimitar Antenna structure (10B)

4.4.1.3.3 Side Section, Exterior.

- All Baseline AES Phase I Lab structural modification kits
- Side ERA Compatibility Rack structure (15L). The following experiment equipments will be mounted on this rack:
  - Alpha Emission electronics (3C)
  - IR Spectral electronics (2 units) (7F)
  - IR Interferometer electronics (7H)
  - Viewfinder electronics (8D)
  - Viewfinder Digital Controller (8E)
  - Probe Support Equipment (4 packages) (10B)

4.4.1.3.4 Aft Section, Exterior.

- All Baseline AES Phase I Lab structural modification kits
- Omni Directional Scimitar Antenna structure (10B)

4.4.1.4 Install Structure for Modification Kits and Compatibility Packages in Descent Stage

4.4.1.4.1 Top Section.

- IR Grating Spectrometer and 16-inch Telescope structure (7D)
- Particle Flux Detector structure (9C)
- Lunar Survey Probes (2) structure - Flight 511 only (10A)
- RF Reflectivity Antenna and Receiver Transmitter structure (12A,B)
- Radar Image Recorder structure (13C)
- Cooling Loop Compatibility Package structure (15D)*

4.4.1.4.2 Side Section, Quad I.

- All Baseline AES Phase I Lab structural modification kits
- Particle Flux Detector structure (9C)
- Passive Microwave Imaging Antenna and Radiometer structure (11A,B)
- Descent Stage Battery structure (2) (15I)
- Electrical Control Assembly structure (15J)
- Thermally Active Experiment Compatibility Module structure. The following experiment equipment will be mounted on this module:

  - o Ultraviolet Camera (6A)
  - o IR Image Scanner (7A)
  - o IR Scanner Recorder (7C)
  - o IR Interferometer Optical Head (7G)
  - o Multi-spectral Cameras (4 units) (8B)
  - o Cartographic Camera (15A)
  - o Stellar Camera (15B)

4.4.1.4.3 Side Section, Quad II.

- All Baseline AES Phase I Lab structural modification kits
- Solar Radiation Monitoring Platform structure (1E). The following experiment equipment is mounted on this platform:

  - o Solar Radiation Monitor and Calibration Source (1B,D)

- Magnetometer Boom Structure (4E). The following experiment equipment is mounted on this boom:

  - o Rubidium Vapor Magnetometer (4F)
  - o Fluxgate Magnetometer (4G)
  - o Magnetometer Electronics (4H)
  - o Particle Flux Detector structure (9C)

4.4.1.4.4 Side Section, Quad III.

- All Baseline AES Phase I Lab structural modification kits
- No. 2 Collimating Tube structure (9B)
- Particle Flux Detector structure (9C)

- - - - - - -

*The Cooling Loop Compatibility Package (15D) is an integral part of the Thermally Active Compatibility Module.

- Passive Microwave Spectral Measuring Antennas and Radiometer structure (11C, D, E)
- Descent Stage Battery structure (2) (15I)
- Electrical Control Assembly structure (15J)

4.4.1.4.5 Side Section, Quad IV.

- All Baseline AES Phase I Lab structural modification kits
- Thermally Passive Experiment Compatibility Module structure. The following experiment equipment will be mounted on this module:
  - o X-Ray Fluorescence Detector and Calibration Source (1A,D)
  - o Gamma-Ray Mapping Spectrometer and Calibration Source (2A,B)
  - o Alpha-Emission Detector Head and Calibration Source (3A,B)
  - o Proton-Alpha Spectrometer (4A)
  - o High-Energy Selectron Spectrometer
  - o Low-Energy Selectron Spectrometer (4C)
  - o Rotating Resonance and Scanning Head (5A)
  - o Integrating Sphere (5B)
  - o Particle Flux Detector (9C)
  - o Horizon Sensor (15C)

4.4.1.4.6 Bottom Section.

- Panoramic Cameras structure (8A)
- No. 1 Collimating Tube structure (9A)
- Particle Flux Detector structure (9C)
- Lunar Survey Probes structures (2) (10A)
- Radar Imager Radar, Star Camera, and Antenna structure (13A,B,D)
- 400-MHz Altimeter and Antenna structure (13E,F)
- 8-GHz Altimeter and Antenna structure (13G,H)

4.4.1.5 Install Fluid Lines, Electrical Harness, and Equipment in Modification Kit and Compatibility Package in Ascent and Descent Stages.

- Remove each stage from its workstand, transfer the stages to the integration area, rotate and clean each stage, and install each stage in its workstand.
- Install all Baseline AES Phase I Lab modification kit fluid lines, electrical harnesses, and equipment.
- Install all experiment integration compatibility package fluid lines, electrical harnesses,and equipment.
- Gross-leak check all fluid line installations
- DITMCO check all electrical harness installations
- Install all GSE harnesses

4.4.1.6 Checkout Ascent Stage and Descent Stage Fluid Systems

- Remove each stage from its workstand, transfer the stages to separate cells of the Hypergolic Test Building, and install each stage in its test stand.
- Conduct proof-pressure tests on the ECS baseline. AES Phase I Lab modification kits and experiment integration compatibility packages to demonstrate the integrity of each installation.

- Conduct leak checks at operating pressures on the fluid sections of the RCS, ECS, applicable modification kits, and compatibility packages.
- Conduct functional and operational checks using referee or inert fluids on the fluid sections of the RCS, ECS, applicable modification kits, and compatibility packages.

4.4.1.7 Install Experiment ERA's and Mechanical Experiment Interfaces in Ascent and Descent Stages

- Remove each stage from its test stand, transfer the stages to the integration area, rotate and clean each stage, and install each stage in its workstand.
- Install all mechanical interfaces for experiment equipment.
- Electrically mate the Ascent Stage to the Descent Stage.

4.4.1.8 Perform Integrated Subsystem Verification Tests

- Perform an end-to-end functional demonstration of the Phase I Lab to verify qualitatively the performance of the installed modification kits and compatibility packages by applying stimuli to the interfaces at a minimum number of levels and measuring the responses by ACE-S/C.

4.4.1.9 Install Electrical Experiment Interfaces in Ascent and Descent Stages.

- Install all electrical interfaces for experiment equipment

4.4.1.10 Perform Payload Integration Verification Tests

- Perform an end-to-end functional verification of the Phase I Lab to verify qualitatively the performance of the integrated Lab as a system by applying stimuli to the experiments at a minimum number of levels and measuring the responses by ACE-S/C.

4.4.1.11 Perform Ascent Stage and Descent Stage Vibration Checks

- Supply low-level vibration inputs to the Ascent Stage and Descent Stage, with the stages electrically mated and all systems operating, to check for systems response and loose articles.

4.4.1.12 Perform Ascent Stage Cabin Leakage Checks

- Electrically de-mate the Ascent Stage from the Descent Stage
- Pressurize the Ascent Stage cabin to 5.0 psig and check for leakage.

4.4.1.13 Install Ascent Stage and Descent Stage Thermal Shielding

- Install pre-selected thermal shielding on the Ascent and Descent Stages.

4.4.2 Test Hardware and Mockups

The manufacturing tasks associated with the design and development phase of the Phase I Lab will include the fabrication of new test units or modification of LEM test hardware. The major test items required are as follows:

- Fabricate and/or modify the following test articles in accordance with subparagraph 5.1.1, Volume XVII, Manufacturing Plan, AES-LEM, Phase B Final Report:

  - o LM-1: wood and metal mockup
  - o EHI: metal skeleton of Ascent/Descent Stages
  - o LLTA-1: Ascent/Descent Stages completely structurally and thermally functional
  - o LLTA-2: LTA-8 modified to lab configuration

- Fabricate experiment integration test articles

  - o Air lock plus primary support structure test elements (2)
  - o Viewfinder test element consisting of viewfinder plus LEM window test element

- Fabricate an additional descent stage for LLTA-2 test article. The second descent stage will be required to facilitate scheduling the descent stage from MSC to Grumman for flight mission modifications. It is assumed that ascent stage modifications required at MSC are negligible.

4.5 TOOLING

4.5.1 Tooling Requirements

The tooling required for the integration and installation of the experiment packages on the baseline Lab includes detail parts, subassembly, and installation fixtures. Each flight has been analyzed for the aforementioned requirements and summarized as follows:

4.5.1.1 Flights 507/511

Tooling fixtures are required for the following subassemblies:

- Thermally Passive Experiment Compatibility Module
- Thermally Active Experiment Compatibility Module
- Lunar Probe Racks (Descent Stage)
- Lunar Probe Rack (Ascent Stage - Flight 511 only)
- Cooling Loop Compatibility Package
- Passive Microwave structure
- ERA Compatibility Rack
- Camera substructure
- Additional Battery Support structure
- Cabin Display and Control Panels Substructure

The following subassemblies will require installation and alignment fixtures that will be utilized at KSC to locate and install the secondary structural hard points:

- Hinges for the Thermally Passive Experiment Compatibility Module
- Hinges for the Thermally Active Experiment Compatibility Module
- Truss installation of Side ERA Rack - Ascent Stage
- Lunar Rack installation - Ascent Stage (Flight 511 only)
- Substructure for Cameras - Descent Stage

- Stable Platform - Descent Stage
- Substructure for Image Antenna
- Collimating Tube
- 400-MHz Altimeter Antenna
- 8-GHz Altimeter Antenna
- Passive Microwave Spectral Antenna
- RF Reflectivity Antenna

4.5.1.2 Flight 509

Tooling fixtures are required for the following subassemblies:

- Counter-Rotating Platform
- Side ERA Rack
- ±Y Adapter - Descent Stage
- Substructure for Circuit Breaker Panel

Installation fixtures are required for the following subassemblies:

- Support Structure for Counter-Rotating Platform
- Support Structure for ERA Rack
- ±Y Adapter
- Battery Support Structure
- Magnetometer Substructure
- Small Maneuvering Satellite Substructure
- Radio Astronomy
- Stem Rod
- Data Recorder Substructure

4.5.1.3 Flight 214

Tooling fixtures are required for the following subassemblies:

- ±Y Bay Structure - Descent Stage
- Outrigger Battery Panels
- Z Substructure
- ERA Side Rack
- Coolant Package Substructure

Installation fixtures are required for the following subassemblies:

- Optical Guidance System Laser Transceiver Substructure
- Canister Assembly - Reflective Structure
- Small Maneuvering Satellite Mounting Structure
- Launch and Docking Mechanism Substructure
- Net Capture Mechanism Substructure
- Ruby Laser Transceiver Substructure
- ±Y Bay Substructure
- Magnetic Capture Mechanism Substructure
- Radiation Monitoring Substructure
- Navigation and Guidance System Altimeter Antenna (Quad IV)
- Orbit Maneuvering and Docking Substructure
- ERA Compatibility Rack

- Omni Antenna Substructure
- Sun Antenna Substructure
- Horizon Scanner
- Coolant Package - Ascent Stage

4.5.1.4 Flight 216

Tooling fixtures are required for the following subassemblies:

- Air Lock - Center Bay Descent Stage
- Quad I Substructure
- ±Y Substructure
- -Z Bay Substructure
- Battery Support Structure - Descent Stage
- ERA Rack - left and right
- Quad IV Substructure
- Manned Locomotion and Maneuvering Capability Substructure

Installation fixtures are required for the following subassemblies:

- +Z Bay Substructure - extended rod
- ERA Racks - left and right
- Battery Support Structure - Descent Stage
- Radiation Monitoring Substructure - Quad II
- Omni Antenna - forward and aft
-

4.6 FACILITIES

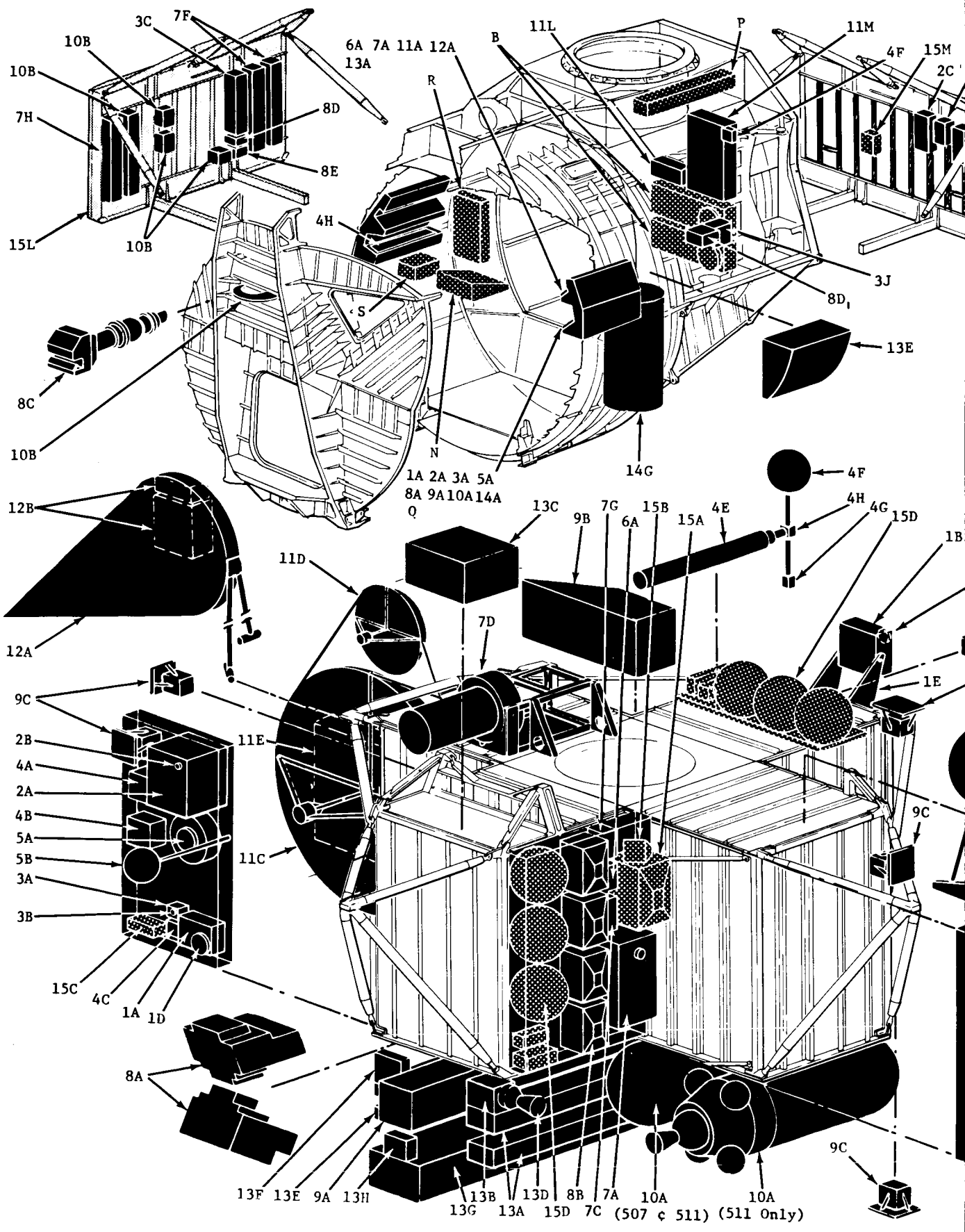
4.6.1 Requirements

The modification facility, as described in Volume XVII, Manufacturing Plan, and Volume XXI, Facilities Plan, of the Phase B Final Report will generally satisfy the facility requirements of the payload integration task. This facility provides work stations, however additional area is required for unpacking, storage, and checkout of the experiments. This additional area, by station, is required for:

- Work Station - High Bay (Volume XVII)
  - Storage and unpacking
  - Rotating and cleaning
  - Ascent Stage assembly
  - Descent Stage assembly
  - ACE-S/C pick-up and transmission
- Bench Work Station - Low Bay (Volume XVII)
  - Support equipment checkout
  - System/subsystem checkout
  - System/subsystem subassembly

- Bench Work Station - Low Bay (Additional)
    - o Experiment system/subsystem checkout
    - o Experiment system/subsystem assembly
    - o Experiment system/subsystem storage

The total integration facility requirements are described in detail in Paragraph 7.3, Manufacturing Facilities.


3C
7F
10B
10B
7H
15L
10B
6A 7A 11A 12A
13A
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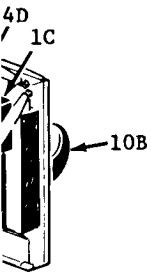
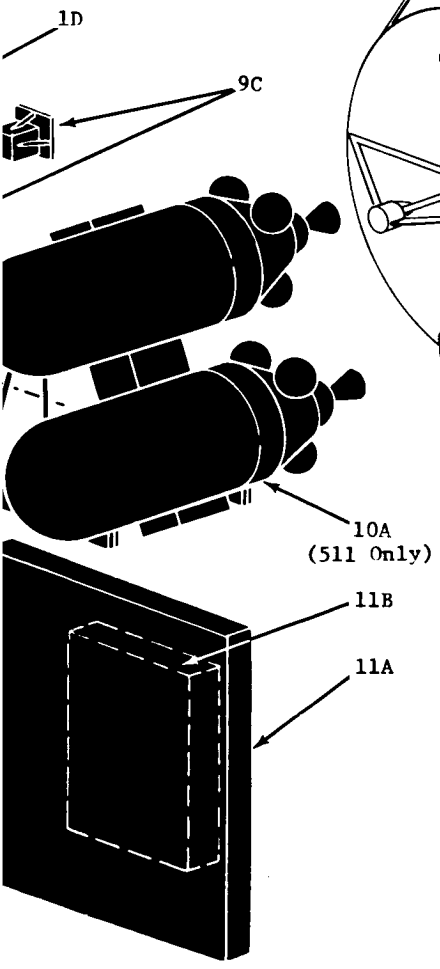
15C
4C
1A
1D
8A
13F
13E
9A
13H
13G
13B
13A
13D
15D
8B
7C
7A
10A
(507 ç 511)
10A
(511 Only)
9C

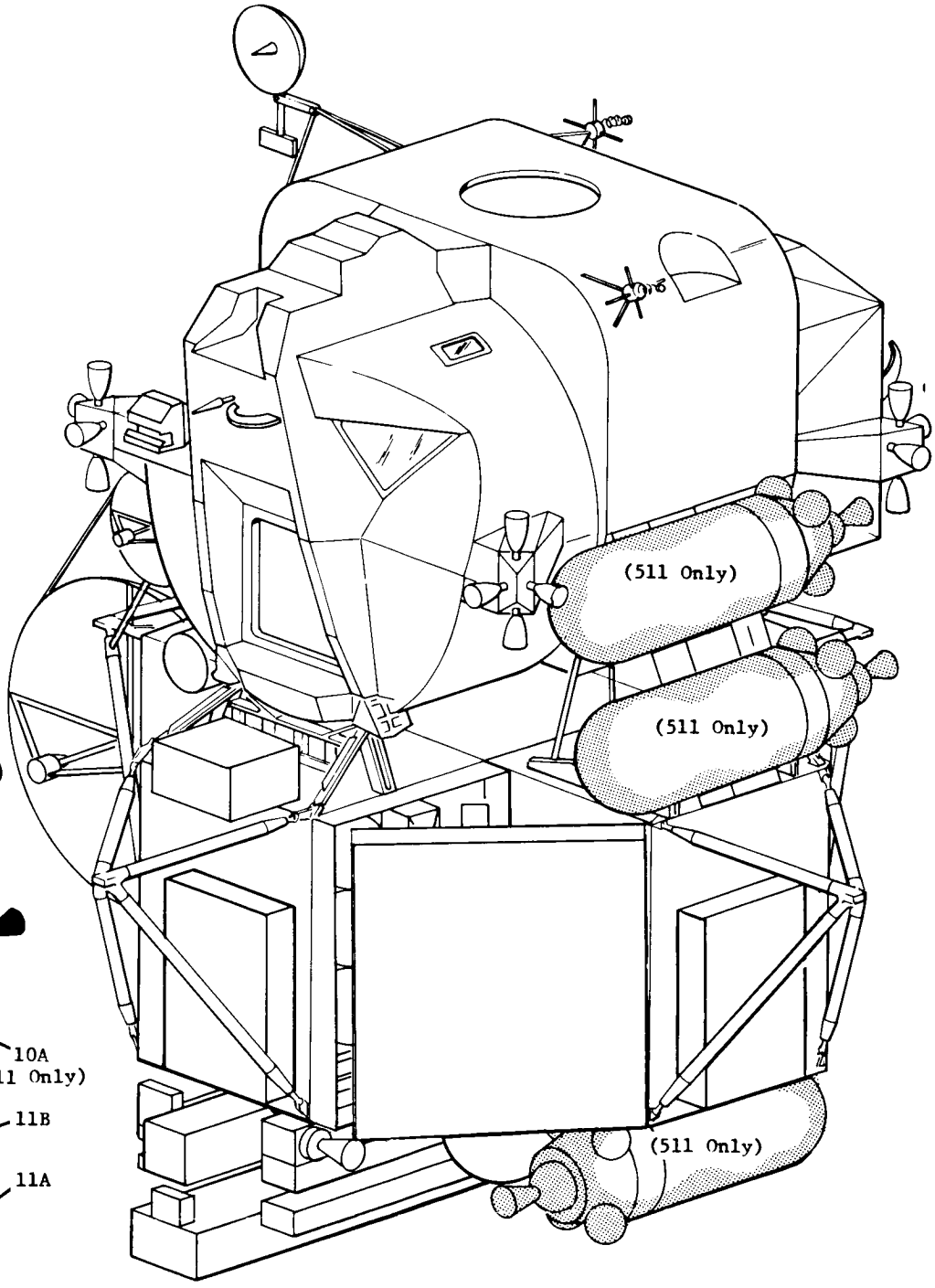
4.2-1-1



ASCENT

DESCENT





KEY

1
1A
1C

2
2A
2C

3
3A
3C
3J

4
4D
4F
4H

5
5A

6
6A

7
7A
7F
7H

8
8A
8C
8D
8D,
8E

9
9A

10
10A
10B

11
11A

4.2-1-2

ASCENT STAGE

EXPERIMENT/COMPONENT

X-RAY FLUORESENCE
Count Rate Mtr
Electronics

GAMMA RAY MAPPING
Count Rate Mtr
Electronics

ALPHA EMISSION
Count Rate Mtr
Electronics
Pulse Cnvtr

RADIATION MONITORING
Pulse Hgt Anal
Bat Charger
TEIC Rate Mtr

REMOTE GEOCHEM SNS
Cntl Pnl

U.V. ABSORPTION
Cntl Pnl

I.R. Surveying
Cntl Pnl
Spectral Elct
Intfermtr Elct

PHOTO INVESTIGATION
Cntl Pnl
Viewfinder
Viewfinder Elct
Film Procsr
Viewfinder Dig Cntlr

MICROMETEORITE EXP
Cntl Pnl

LUNAR SURVEY
Cntl Pnl
Probe Supt Equip
Omni-Ant
VHF Diplexer
VHF Transcvr
Sig Procsr
C/O & Aln Elct

PASSIVE MICROWAVE
Cntl Pnl

11L Format Cnvtr
11M Kalvar Rcdr

12 R.F. REFLECTIVITY
12A Cntl Pnl

13 RDR IMAGE, ALTM, & SURF STATE
13A Cntl Pnl
13E Tape Rcdr

14 LUNAR GRAVITY
14A Cntl Pnl
14G Gradiometer

15 COMPAT PKGS
15L Era Rack
15M S/D
B Data Storage Elect
N Video Displ
P Circuit Bkr Pnl
Q Horizon Sensor Pnl
R Time Share Displ
S Contl Lever (View Finder)

DESCENT STAGE

KEY EXPERIMENT/COMPONENT

1 X-RAY FLUORESENCE
1A Detector
1B Solar X-Ray Mon
1D Calib Source
1E Platform

2 GAMMA RAY MAPPING
2A Spectrometer
2B Calib Source

3 ALPHA EMISSION
3A Detector
3B Calib Source

4 RADIATION MONITORING
4A Proton Alpha Spect
4B Hi Ener Elct Spect
4C Low Ener Elct Spect
4E Mag Boom
4F Rubidium Vapor Mag
4G Fluxgate Mag
4H Mag Elct

5 REMOTE GEOCHEM SNS
5A Rot Reson & Scan HD
5B Int Sphere

6 U.V. ABSORPTION
6A U.V. Camr

7 I.R. SURVEYING
7A Image Scanner
7C Scanner RCDR
7D GRTG Spect & Scope
7G Intfermtr Opt HD

8 PHOTO INVESTIGATION
8A Pan Camr
8B Multi-Spectral Camr

9 MICROMETEORITE EXP
9A Collimating Tube
9B Collimating Tube
9C Prtcl Flux Detector

10 LUNAR SURVEY
10A Probes - 507(2),511(6)

11. PASSIVE MICROWAVE
11A Image Ant
11B Image Radmtr
11C Spectral Ant
11D Spectral Ant
11E Spectral Radmtr

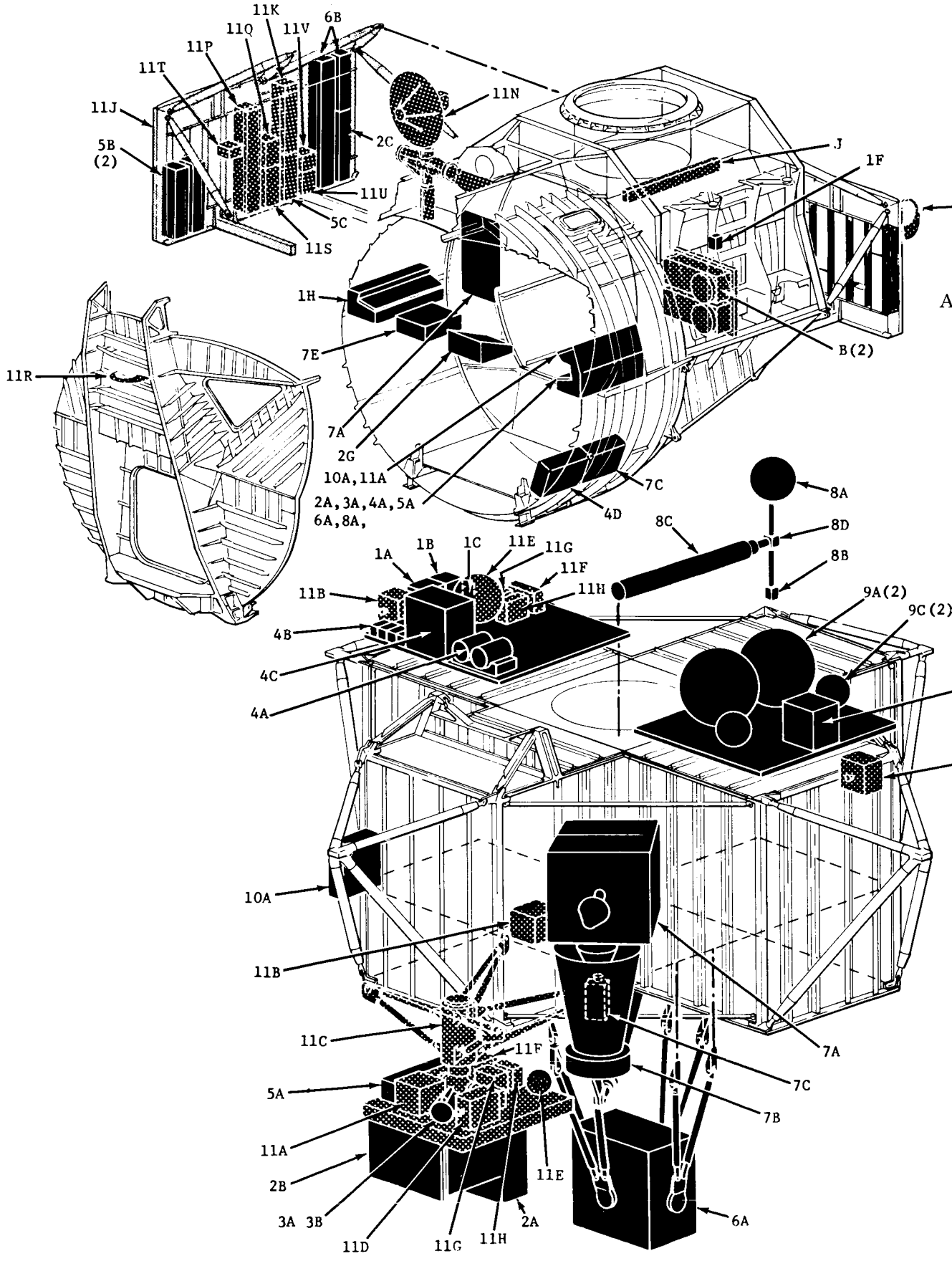
12 R.F. REFLECTIVITY
12A Antenna
12B Rcvr & Tx

13 RDR IMAGE, ALTM, & SURF STATE
13A Rdr Imager Ant
13B Image Rdr
13C Rdr Imager Rcdr
13D Star Camr
13E 400 MHz Alt Ant
13F 400 MHz Alt
13G 8 GHz Alt Ant
13H 8 GHz Alt

15 COMPAT PKGS
15A Cartographic Camr
15B Stellar Camr
15C Horizon Sensor
15D Cooling Loop Pkg
Water Tanks
Pump
Accumulator
Boiler

Figure 4.2-1 Phase I Lab Flights, 507/511

Grumman


11K
11Q
11V
6B
11P
11T
11J
5B
(2)
2C
11N
J
1F
11U
5C
11S
1H
7E
11R
7A
2G
10A, 11A
2A, 3A, 4A, 5A
6A, 8A,
7C
4D
B(2)
8A
8C
8D
8B
1A
1B
1C
11E
11G
11F
11H
11B
4B
4C
4A
9A(2)
9C(2)
10A
11B
11C
11F
5A
11A
2B
3A
3B
11D
11G
11H
2A
11E
6A
7A
7C
7B

4.2-2-1

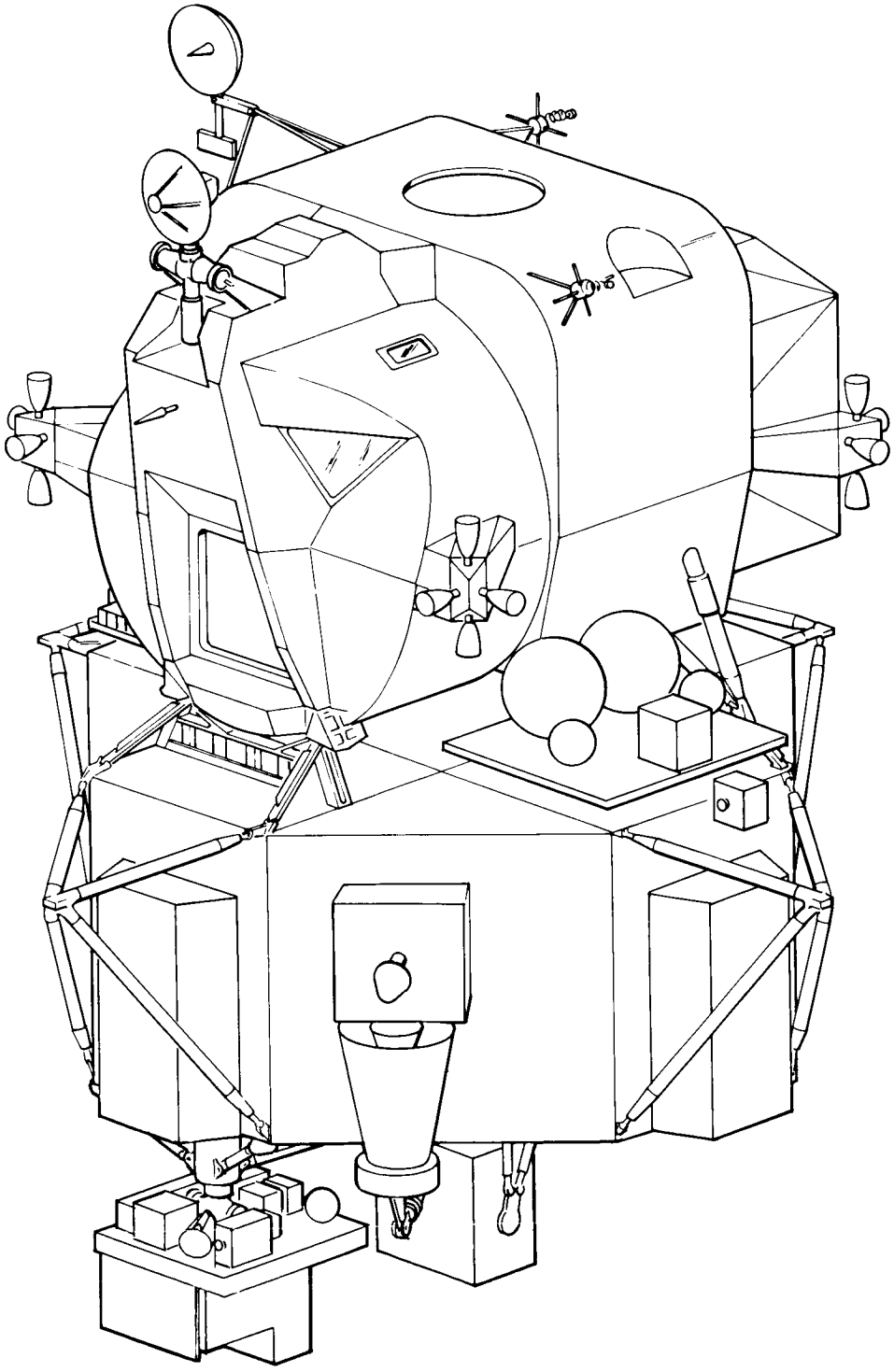
11R

SCENT

9B

11B

DESCENT



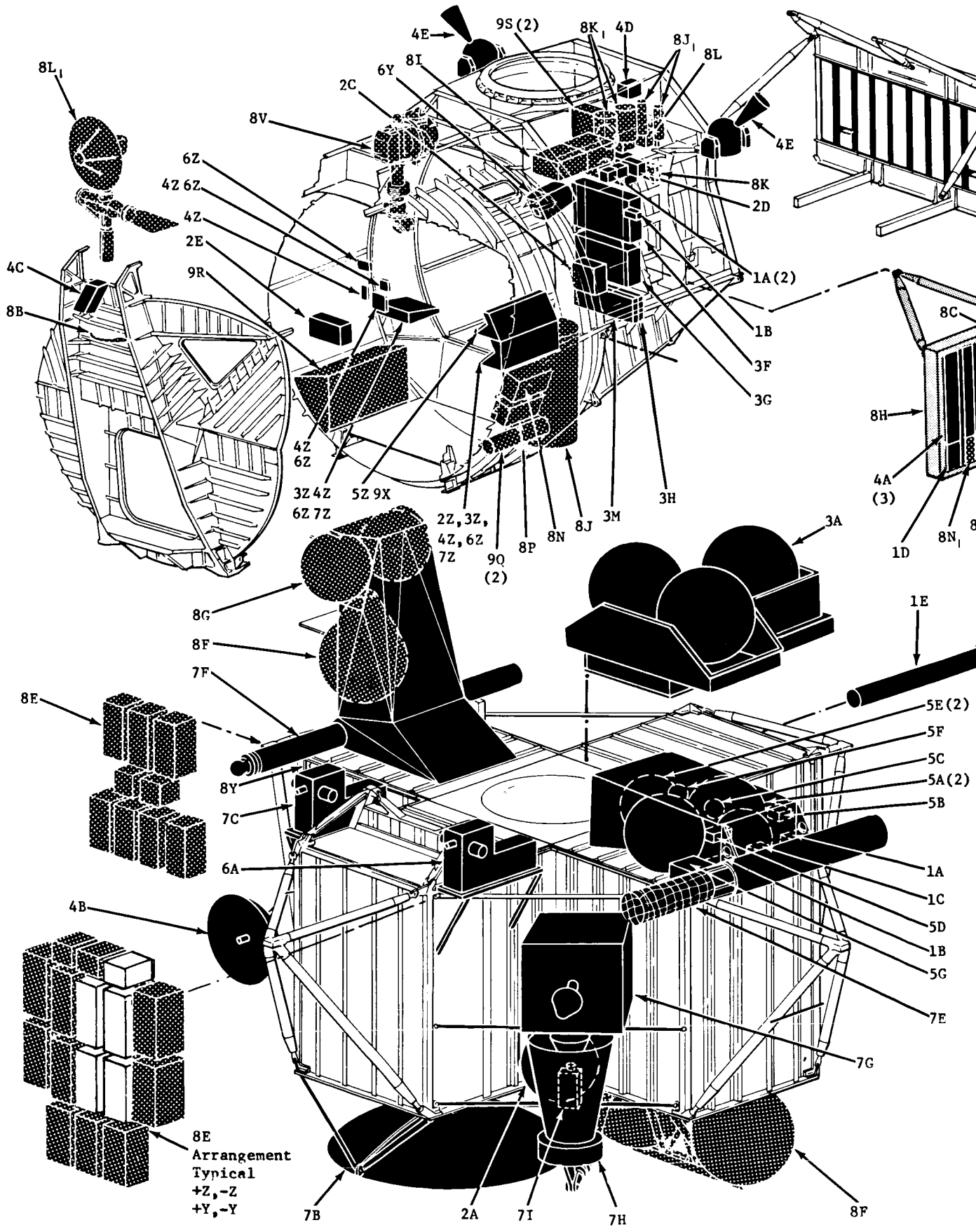
4-2-2-2

ASCENT STAGE	
KEY	EXPERIMENT/COMPONENT
1	RADIATION MONITORING
1H	T.E.I.C. Rate Mtr
1F	Bat Chgr
2	X-RAY ASTRONOMY
2A	Cntl Pnl
2C	Electronics
2G	T.V. Displ
3	MARTIAN ATMOSPHERE
3A	Cntl Pnl
4	ARTIFICIAL COMETS
4A	Cntl Pnl
4D	Frame Camr
5	FAR UV IMAGE CNVTR
5A	Cntl Pnl
5B	Camr Chain Elct
5C	Image Record Equip
6	RADIO ASTRONOMY
6A	Cntl Pnl
6B	Radmtr & Elct
7	SM MANUVR SATELLITE
7A	Cntl Pnl
7C	Movie Camr
7E	Cntl Lever
8	MAGNETOMETER
8A	Cntl Pnl
9	COMPAT PKGS
B	Data Storage Elect
J	Circuit Bkr Pnl
10	PROP HOL, PART I
10A	Cntl Pnl
11	EXTND ROD TST, PART 4
	COMPAT PKGS
11A	Cntl Pnl
11J	E.R.A. Rack
11K	Inverter
11N	Rvr Ant
11P	Rvr Elct
11Q	Transcvr
11R	Omni-Ant
11S	Sig Procsr
11T	Diplexer
11U	S/D
11V	Photo Time Ref

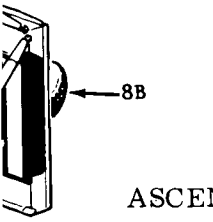
DESCENT STAGE	
KEY	EXPERIMENT/COMPONENT
1	RADIATION MONITORING
1A	Proton Alpha Spect.
1B	Hi Ener Elct Spect
1C	Low Ener Elct Spect
2	X-RAY ASTRONOMY
2A	X-Ray & Star Snsr
2B	Calib Source Assy
3	MARTIAN ATMOSPHERE
3A	Spectrometer
3B	Error Sensor
4	ARTIFICIAL COMETS
4A	Fluid Cntr
4B	Photometers
4C	Spectrometer
5	FAR U.V. IMAGE CNVTR.
5A	Elec Opt Unit
6	RADIO ASTRONOMY
6A	Antenna Assy
7	SM MANUVR SATELLITE
7A	Satellite
7B	Dock & Lnch Mech
7C	Remote T.V. Camr
8	MAGNETOMETER
8A	Rubidium Vapor Mag
8B	Fluxgate Mag
8C	Mag Boom
8D	Electronics
9	PROP HDL, PART I
9A	Water Cntr
9B	Fuel Trans Syst Elct
9C	Gas Bottles
10	EXTND ROD TST, PART 4
10A	Stem Rod Mech
11	COMPAT PKGS
11A	Stellar Camr
11B	RMTE Time Lpse Camr
11C	Ctr Rot Mech
11D	T.V. Camera
11E	Water Tanks
11F	Accumulators
11G	Water Boilers
11H	Pumps

Figure 4.2-2 Phase I Lab, Flight 509

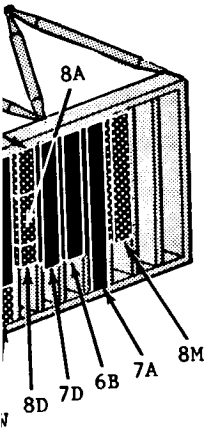
Grumman

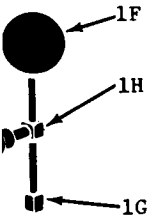

4E
9S(2)
8K
4D
8J
8L
8I
6Y
2C
8V
8L
6Z
4Z 6Z
4Z
2E
9R
4C
8B
4E
8K
2D
1A(2)
1B
3F
3G
8C
8H
4A
(3)
1D
8N
4Z
6Z
3Z 4Z
6Z 7Z
5Z 9X
2Z, 3Z,
4Z, 6Z
7Z
9Q
(2)
8P
8N
8J
3M
3H
3A
8G
8F
7F
1E
8E
5E(2)
5F
5C
5A(2)
5B
8Y
7C
6A
1A
1C
5D
1B
5G
4B
7E
7G
8E
Arrangement
Typical
+Z,-Z
+Y,-Y
7B
2A
7I
7H
8F

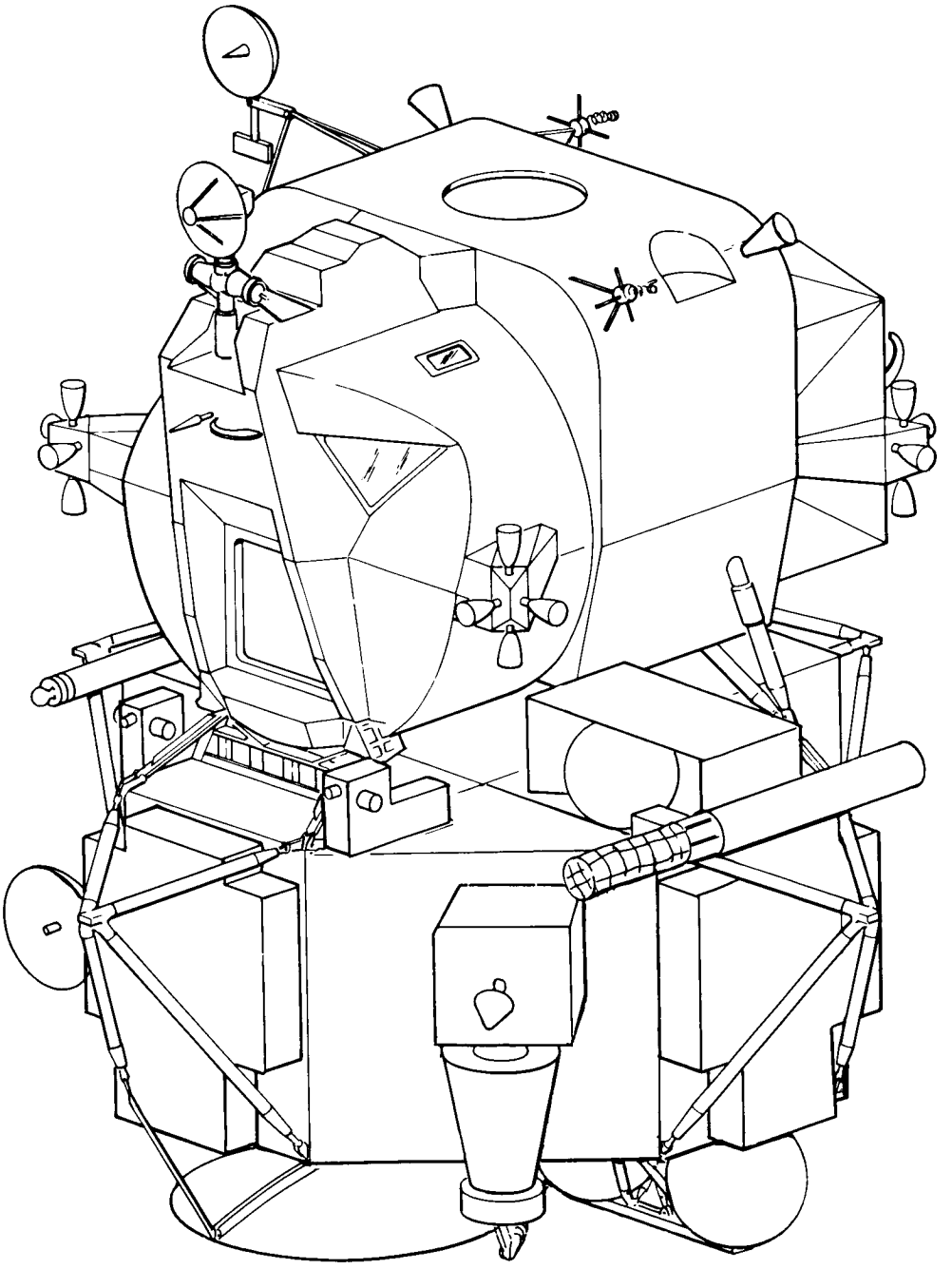
4.2-3-1



ASCENT







DESCENT

4-2-3-2

ASCENT STAGE

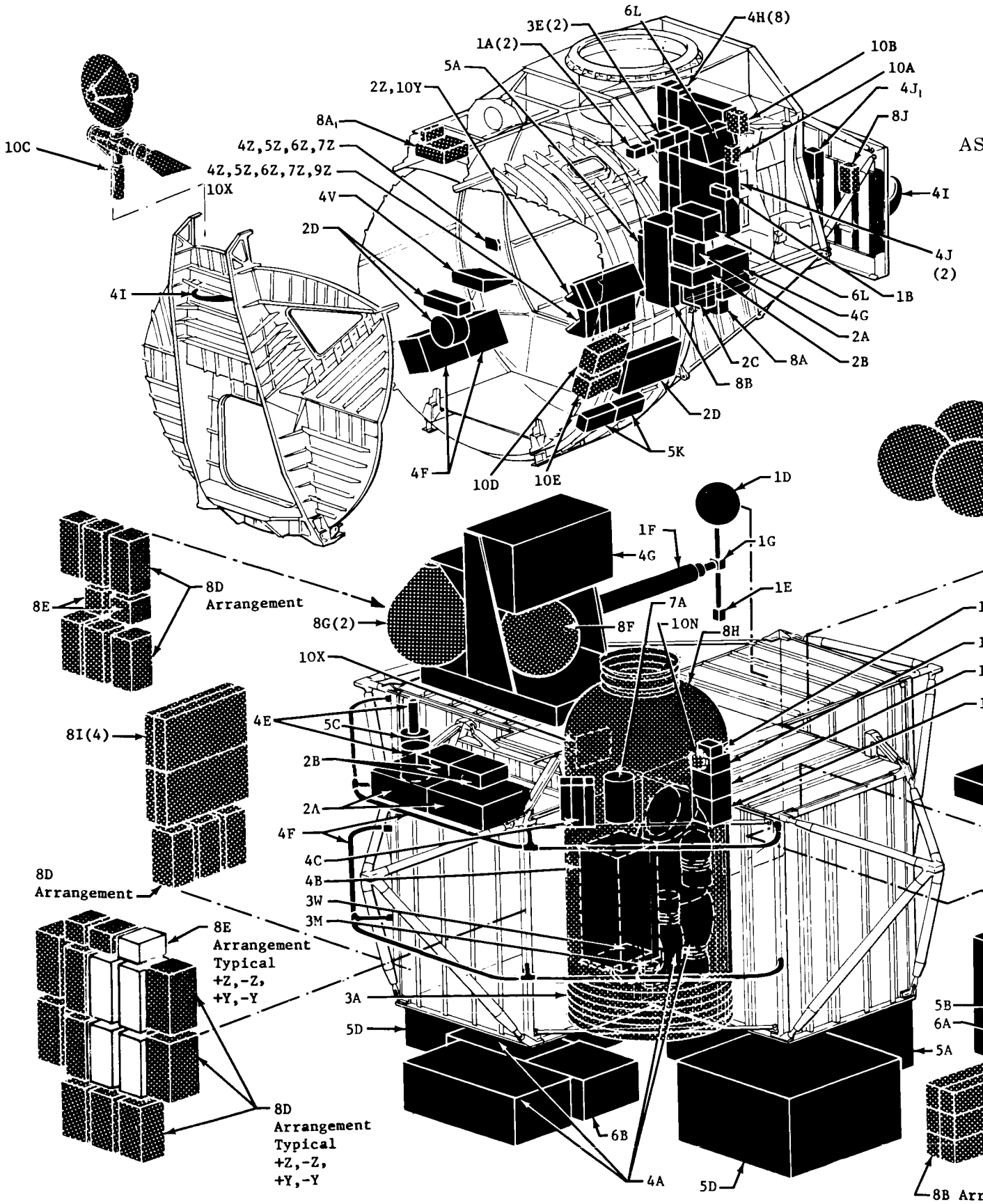
KEY	EXPERIMENT/COMPONENT
1	RADIATION MONITORING
1A	TEIC Rate Mtr
1B	Bat Chgr
1D	Pulse Hgt Anal
2	DEPLOYMENT OF REFL STRC
2C	Binoculars
2D	Movie Camr - 16mm
2E	Film
2Z	Cntls & Displ
3	CNTL MOM GYRO
3F	L.G.C.
3G	C.D.U.
3H	P.S.A.
3M	S/D
3Z	Cntls & Displ
4	ON-BOARD G&N SYS
4A	Altimeter
4C	Horiz Scanner
4D	Sun Sensor
4E	Star Tracker
4Z	Cntls & Displ
5	PROP HDL, PART II & III
5Z	Cntls & Displ
6	OPT GUID SYS FOR RV
6B	Laser Elct
6Y	T.V. Monitor
6Z	Cntls & Displ
7	ORBTL MANUVR & DOCK
7A	L.R.R. Elct
7D	Laser Elct
7Z	Cntls & Displ
8	COMPAT PKGS
8A	Transceiver
8B	Omni Ant
8C	Sig Procsr
8D	Diplexer
8H	Side Cold Plate
8I	Water Boiler
8J	Food
$8J_1$	Pump
8K	R&D Dplxr
$8K_1$	Accumulator
8L	R&D Transmtr
$8L_1$	Rvr Ant
8M	Rvr Elct
8N	D.C.A.
$8N_1$	S/D
8P	PCA
8V	I.M.U.
8W	Pulse Tor Assy
9	ADDITIONAL DATA
9Q	Suit SVC Kit
9R	Garments
9S	Data Storage Elct
9X	Circuit Bkr

DESCENT STAGE

KEY	EXPERIMENT/COMPONENT
1	RADIATION MONITORING
1A	Proton Alpha Spect
1B	Hi Ener Elct Spect
1C	Low Ener Elct Spect
1E	Mag Boom
1F	Rubidium Vapor Mag
1G	Fluxgate Mag
1H	Mag Elct
2	DEPLOYMENT OF REFL STRC
2A	Canister Assy
3	CNTL MOM GYRO
3A	Gyro Assy
4	ON-BOARD G&N SYS
4B	Antenna
5	PROP HDL, PARTS II & III
5A	LOX Cntr
5B	Transfer Sys
5C	Vent System
5D	Fuel Trans Sys
5E	Water Cntr
5F	Gas Cntr
5G	Elec/Mech Spares
6	OPT GUID SYS FOR RV
6A	Laser Transcvr
7	ORBTL MANUVR & DOCK
7B	L.R.R. Ant
7C	Laser Transcvr
7E	Net Capture Mech
7F	Mag Capture Mech
7G	S.M.S.
7H	Dock & Lnch Mech
7I	Remote T.V. Camr
8	COMPAT PKGS
8E	Descent Bat
8F	Water Tanks
8G	GOX Tanks
8Y	Battery Rack

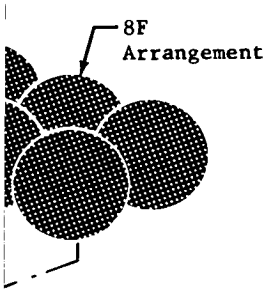
Figure 4.2-3 Phase I Lab, Flight 214

Grumman

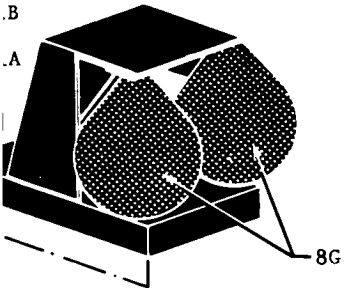

6L
3E(2)
4H(8)
1A(2)
10B
5A
10A
2Z,10Y
4J1
8A1
8J
4Z,5Z,6Z,7Z
10C
4Z,5Z,6Z,7Z,9Z
10X
4V
4I
2D
4J
(2)
6L
1B
4G
2A
2C
8A
2B
8B
2D
5K
4F
10D
10E
1D
1F
1G
4G
1E
8D
Arrangement
8E
7A
8G(2)
8F
10N
8H
10X
4E
8I(4)
5C
2B
2A
4F
4C
4B
3W
3M
8D
Arrangement
8E
Arrangement
Typical
+Z,-Z,
+Y,-Y
3A
5D
5B
6A
5A
6B
8D
Arrangement
Typical
+Z,-Z,
+Y,-Y
4A
5D
8B Arr

4.2-4-1

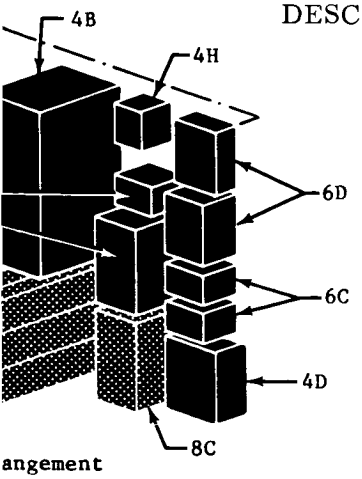
CENT



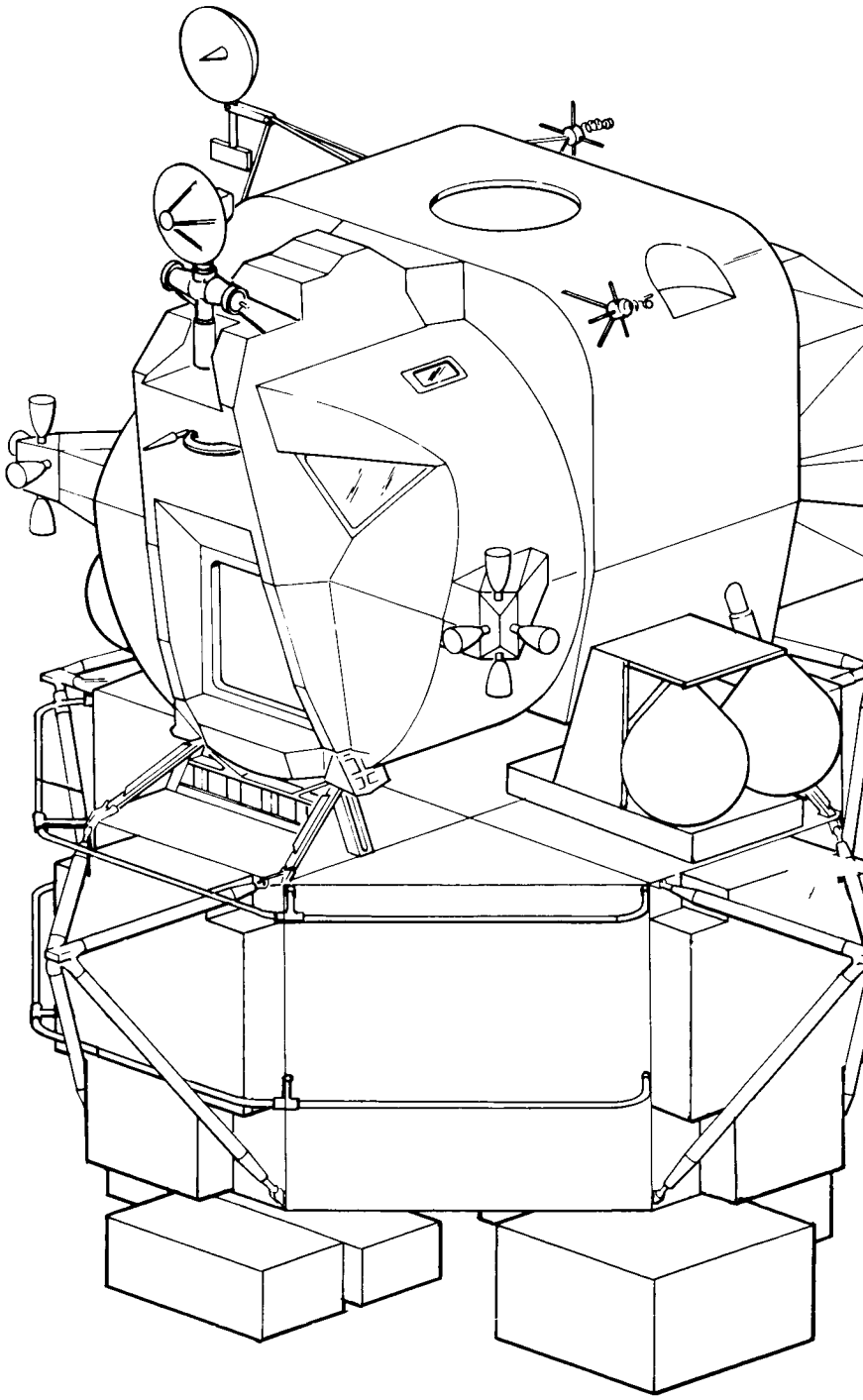
.C
.H
.B
.A



DESCENT



angement

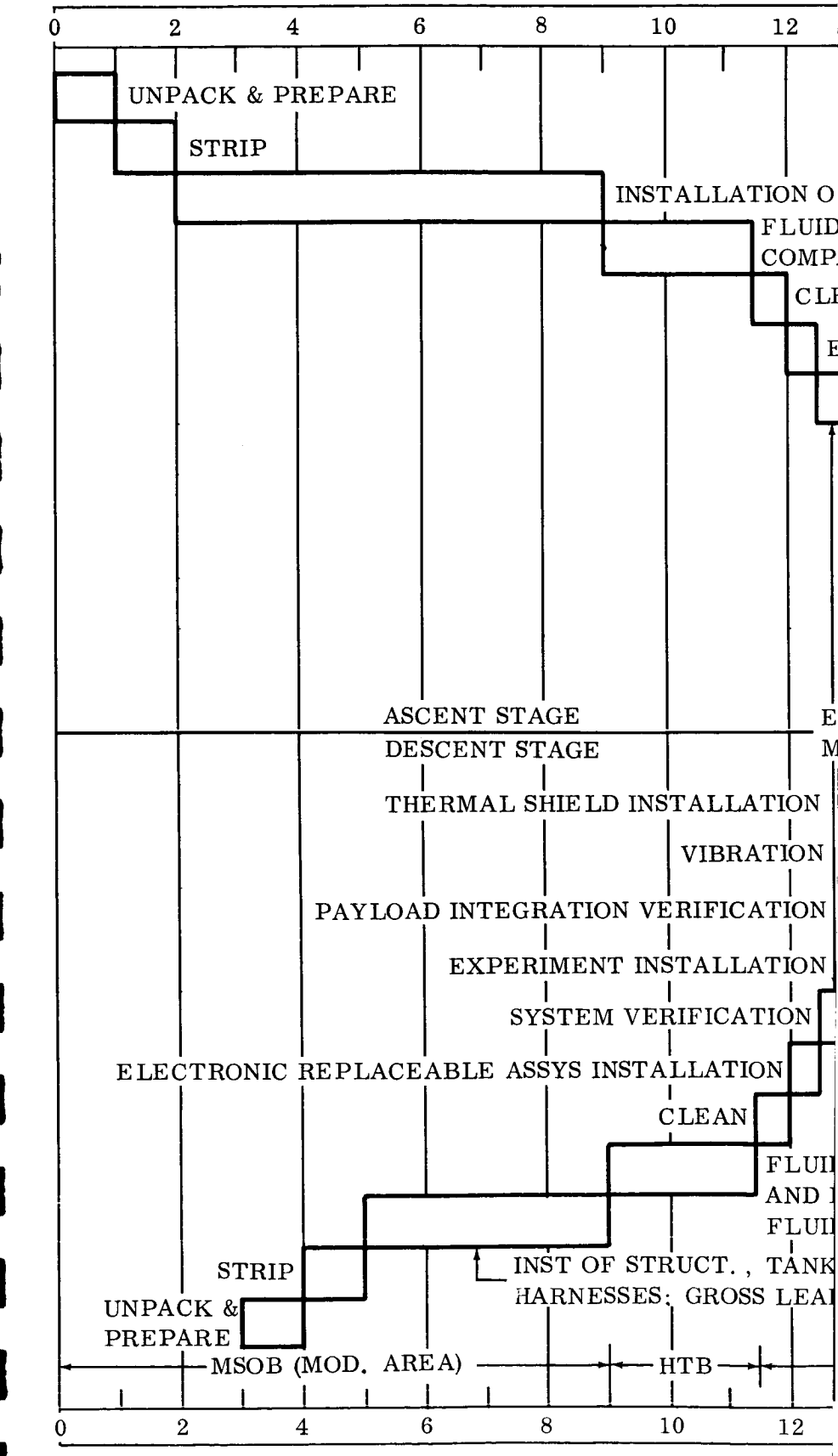


4.2.4.2

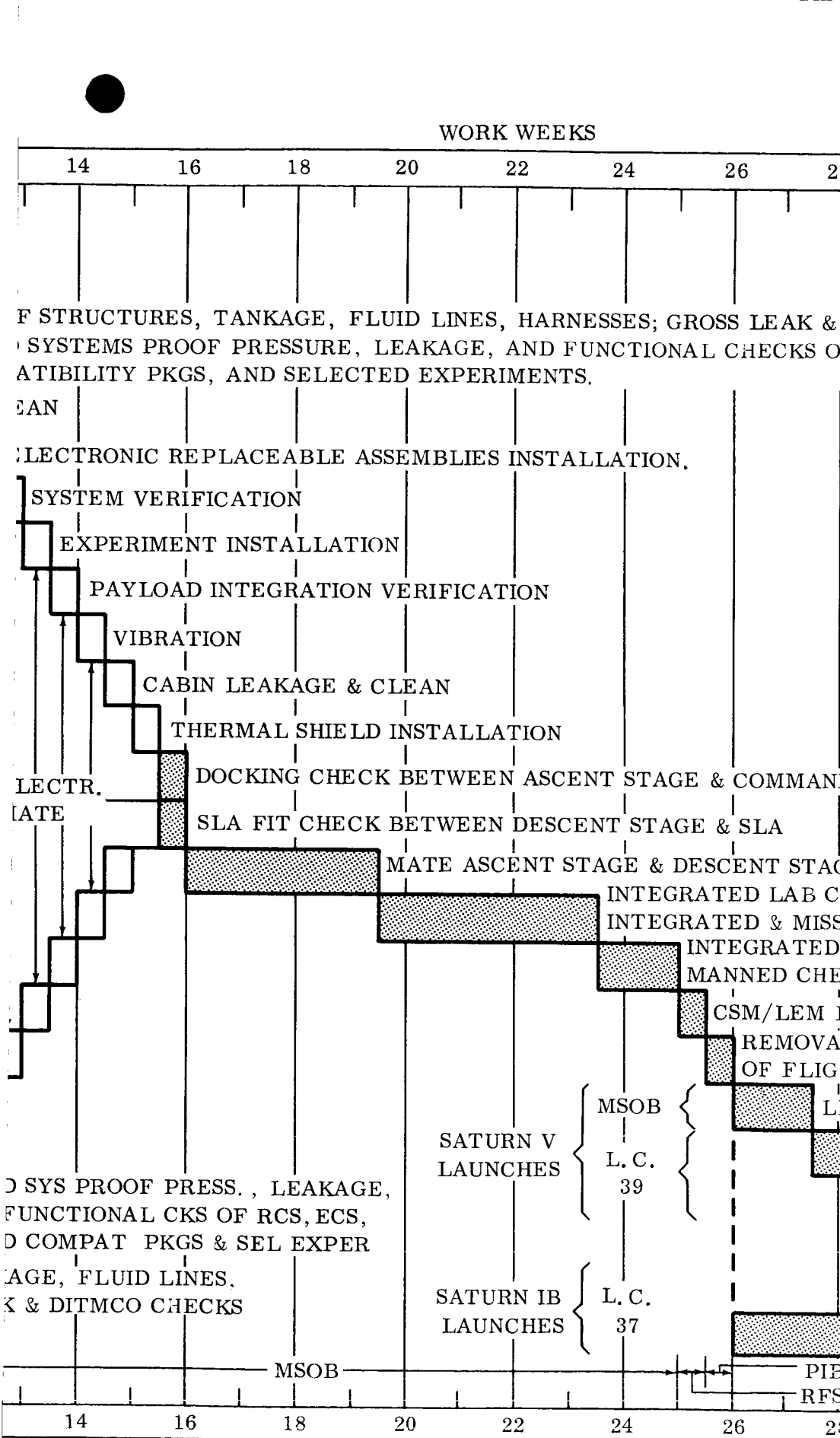
ASCENT STAGE	
KEY	EXPERIMENT/COMPONENT
1	RADIATION MONITORING
1A	T.E.I.C. Rate Mtr
1B	Bat. Chgr
2	EXTND ROD TESTS
2A	Binoculars
2B	Time Lpse Camr - 70mm
2C	Frame Camr
2D	Film
2Z	Cntls & Displ
3	EXPAND AIRLOCK
3E	Movie Camr - 16mm
4	EVAL OF ADV SP SUIT ASSY
4F	ELSS Chest Packs
4G	Biomed Vests
4H	Task Equip Hrns
4I	Omni Ant.
4J	Umbilicals
4J$_1$	Diplexer
4V	T.V. Monitor
4Z	Cntl & Displ
5	MANNED MANUVR TSTS
5A	Life Saving Bag
5K	Sp Suit RPR Kit
5Z	Cntl & Displ
6	EMER TECH FOR RESCUE
6L	Medical Kits
6Z	Cntl & Displ
7	PERSONNEL & CARGO TRANS OPS
7Z	Cntl & Displ
8	CAPILLARY STUDIES
8A	Exp Pkg
8B	Elct Flow Mtr
	COMPAT PKGS
8A$_1$	T.V./Camr Tilt Table
8J	S/D & Photo Time Ref
9	PROP HDL, PART II
9Z	Cntl & Displ
10	COMPAT PKGS
10A	R&D Dplxr
10B	R&D Transmtr
10C	Rvr Ant
10D	D.C.A.
10E	PCA
10X	Cntl & Displ
10Y	Circuit Bkrs

DESCENT STAGE	
KEY	EXPERIMENT/COMPONENT
1	RADIATION MONITORING
1A	Proton Alpha Spect
1B	Hi Ener Elct Spect
1C	Low Ener Elct Spect
1D	Rubidium Vapor Mag
1E	Fluxgate Mag
1F	Mag Boom
1G	Mag Elct
1H	Pulse Hgt Anal
2	EXTND ROD TESTS
2A	Wr Flmt Extnd Rod
2B	Stem Rod Mech
3	EXPAND AIRLOCK
3A	Airlock
3M	Fld Lgt
3W	Cntl Pnl
4	EVAL OF ADV SP SUIT ASSY
4A	Adv Sp Suits
4B	AMU
4C	Restr Sys
4D	Tools
4E	Tether Line
4F	Platf & Rail
4G	AMU Fuel Sup Sys
4H	AMU/Recvr/DCDR
5	MANNED MANUVR TSTS
5A	Cargo Net Mod
5B	Tool Kit
5C	Static Line
5D	Log Matl
6	EMER TECH FOR RESCUE
6A	Personnel Trans Equip
6B	Rescue & PU Tools
6C	Rope Throwing Gun
6D	Tmbl Prevnt Mech
7	PERSONNEL & CARGO TRANS OPS
7A	Mtr/Reel Sys
8	COMPAT PKGS
8B	LiOH - CSM
8C	Food
8D	Descent Bat
8E	ECA
8F	GOX Tanks
8G	Water Tanks
8H	Hard Airlock
8I	AMU Bat
10N	Flood Light
10X	Cntl Pnl

Figure 4.2-4 Phase I Lab, Flight 216


0
2
4
6
8
10
12
UNPACK & PREPARE
STRIP
INSTALLATION O
FLUID
COMP
CLE
E
ASCENT STAGE
DESCENT STAGE
E
M
THERMAL SHIELD INSTALLATION
VIBRATION
PAYLOAD INTEGRATION VERIFICATION
EXPERIMENT INSTALLATION
SYSTEM VERIFICATION
ELECTRONIC REPLACEABLE ASSYS INSTALLATION
CLEAN
FLUI
AND
FLUI
STRIP
INST OF STRUCT. , TANK
HARNESSES; GROSS LEA
UNPACK &
PREPARE
MSOB (MOD. AREA)
HTB
0
2
4
6
8
10
12

4.3-1-1


WORK WEEKS
14
16
18
20
22
24
26
F STRUCTURES, TANKAGE, FLUID LINES, HARNESSES; GROSS LEAK &
SYSTEMS PROOF PRESSURE, LEAKAGE, AND FUNCTIONAL CHECKS O
ATIBILITY PKGS, AND SELECTED EXPERIMENTS.
EAN
LECTRONIC REPLACEABLE ASSEMBLIES INSTALLATION.
SYSTEM VERIFICATION
EXPERIMENT INSTALLATION
PAYLOAD INTEGRATION VERIFICATION
VIBRATION
CABIN LEAKAGE & CLEAN
THERMAL SHIELD INSTALLATION
DOCKING CHECK BETWEEN ASCENT STAGE & COMMAN
LECTR.
IATE
SLA FIT CHECK BETWEEN DESCENT STAGE & SLA
MATE ASCENT STAGE & DESCENT STA
INTEGRATED LAB C
INTEGRATED & MISS
INTEGRATED
MANNED CHE
CSM/LEM
REMOVA
OF FLIG
L
MSOB
SATURN V
LAUNCHES
L. C.
39
D SYS PROOF PRESS., LEAKAGE,
FUNCTIONAL CKS OF RCS, ECS,
D COMPAT PKGS & SEL EXPER
AGE, FLUID LINES,
K & DITMCO CHECKS
SATURN IB
LAUNCHES
L. C.
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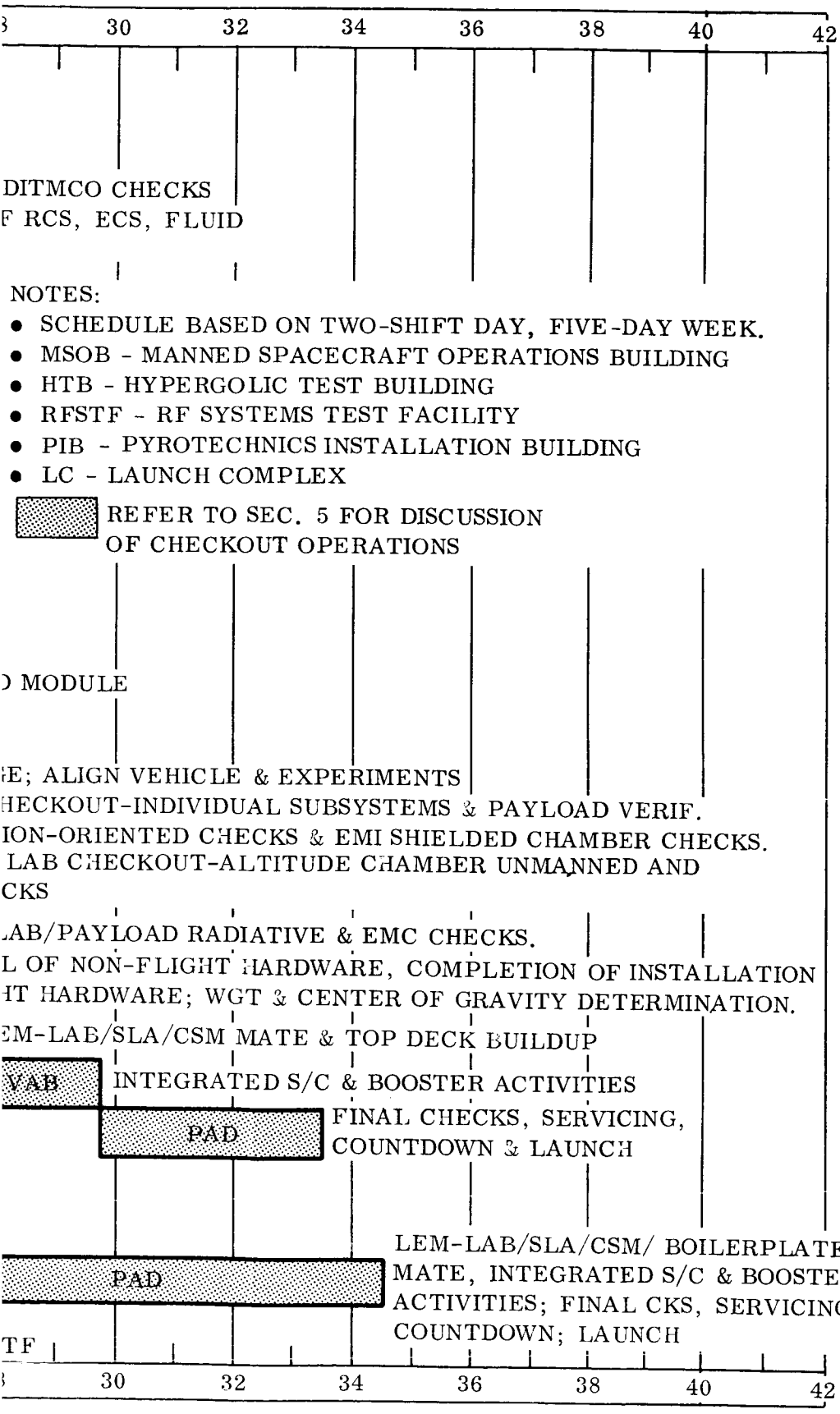

Figure 4.3-1 Modification & Checkout of Phase I Lab at KSC

Grumman

5. OPERATIONS PLAN

5.1 INTRODUCTION

5.1.1 Background

The AES Phase I Lab Prelaunch Operations Plan is based on the presently planned Apollo LEM prelaunch checkout operations and the Recommended Configuration for the Phase I Lab reported in Ref. 5.1 and 5.2, respectively. During the 5-month Phase B Study, the prelaunch checkout rationale, checkout and mission requirements, and KSC vehicle flow for the recommended AES-LEM spacecraft were developed and reported in Ref. 5.3. The prelaunch operations planning was extended in accordance with the Payload Integration Addendum to the Phase B Preliminary Definition Study. The prelaunch and mission operations plans presented in this volume are the result of the analysis of the operations requirements specifically associated with the AES Lab payload integration task.

5.1.2 Scope

The major efforts were directed toward defining the KSC prelaunch operations and flight test objectives for each Lab mission. After defining the concepts, criteria, approach to checkout, and the resulting test requirements, a typical Phase I Lab/Payload operations schedule is presented. The schedule reflects the integration of the KSC modification and checkout functions. The checkout functions are then described for each of the KSC facilities. Finally, the payload support requirements, including Ground Support Equipment, Acceptance Checkout Equipment, and facility utilization are summarized on a per flight basis. In Paragraph 5.5 the flight test objectives for each mission are determined and summarized on a per-flight basis.

5.2 LAB CHECKOUT APPROACH

5.2.1 Concepts and Criteria

The approach to checkout and the resulting requirements which are subsequently presented are based on the following concepts and criteria:

- The experimenter will verify his own experiment package, using bench test equipment to the degree possible in an Earth environment prior to installation in the vehicle.
- The Lab flight configuration will be verified prior to KSC operations as part of the overall Lab Ground Development Test Program.
- Maximum utilization will be made in the prelaunch checkout program of all information and knowledge gained during the Ground Development Test Program.
- To efficiently use test data to develop appropriate trend data relative to the detection of impending malfunctions, common checkout logic and methods will be provided at all checkout locations for equivalent levels of test.
- Whenever technically feasible and practicable, the stimuli and measurements provided for checkout will be of such a nature that all operational and redundant modes of the given system or experiment under test

will be excited and verified. Electrical, mechanical, and fluid " making and breaking " between connections of flight equipment will be minimized for system checkout after the vehicle has been assembled and mated.

- Prelaunch checkout shall be performed at as high an assembly level as possible with the objective of maximum probability of malfunction detection.
- End-to-end testing will be employed as the basic testing approach to prelaunch checkout. End-to-end testing is defined as applying an input stimulus (or set of stimuli) to an identifiable functional flow path or paths, within the system under test, and measuring the system response at the end of that flow path or paths. Deviation from the basic approach will be justified on an individual basis.
- ACE-S/C will be the basic checkout tool for Lab operations at KSC.
- Spacecraft telemetry (flight PCM) will be utilized during prelaunch checkout to the extent possible with no ACE-S/C carry-on duplication, except for those checkout measurements that require an accuracy beyond the capability of the flight PCM Subsystem.
- Measurements that are required for prelaunch checkout will be available in real-time to ACE-S/C.
- Maximum utilization, consistent with safety, will be made of astronauts or their equivalents and onboard controls and displays during checkout.
- When total experiment checkout cannot be accomplished in the Lab, component checkout within the experiment package will be conducted prior to installation. After installation, the experiment interface will be verified.

5.2.2 Checkout Approach

Checkout of Lab and experiments will be accomplished in a building-block approach using the ACE-S/C as the basic checkout tool. The general sequence of operations is:

- Pre-installation and installation checkout in parallel with LEM-to-Lab modification.
- Individual subsystem and experiment verification.
- Integrated Lab/Payload checkout.

5.2.2.1 Pre-Installation and Installation Checkout

Pre-installation and installation checkout will be performed during the Phase I Lab operations flow as shown in the typical KSC Lab flow of Figure 5.3-1. As indicated in the figure, the vehicle arrives at KSC in the basic LEM configuration where modification to the LEM Lab configuration is performed in conjunction with experiment installation. The manufacturing aspects of the modification have been presented in Section 4 of this volume.

As part of the pre-installation checkout, each experiment will undergo a functional verification upon arrival at KSC. The experimenter will supply calibrated stimuli which are compatible, where possible, with the ACE-S/C, for use in functional verification testing both on the bench and when installed in the Lab.

Prior to experiment installation the compatibility equipment/experiment interfaces will be checked. After installation, each experiment will be checked to ascertain proper mechanical installation on the AES-LEM structure, including connector mating and physical mounting. Electrical power will be applied to the experiment and voltage checks made as a cursory indication of proper electrical installation.

5.2.2.2 Individual Subsystem and Experiment Verification

The performance of individual subsystems, compatibility equipment, experiments, and the subsystem/experiment interfaces will be demonstrated predominantly by monitoring system parameters or controlling and monitoring stimuli and measurements through ACE-S/C. These tests will be performed at the Hypergolic Test Building (HTB), the Radio Frequency Systems Test Facility (RFSTF), and the Manned Spacecraft Operations Building (MSOB), according to the Lab/Payload configuration requirements.

5.2.2.3 Integrated Lab/Payload Checkout

The integrated Lab/Payload checkout will be conducted in the MSOB and will encompass four major aspects:

- Integrated system checkout to demonstrate system compatibility by operating the Lab electronics subsystems and experiments through all modes of operation.
- Electromagnetic compatibility (EMC) checks in a controlled EMI environment (shielded chamber) to verify the Lab/Payload electromagnetic compatibility.
- Mission oriented checkout to verify particular mission modes and operations of subsystems and experiments with maximum use of "man-in-the-loop".
- Altitude chamber tests to demonstrate environmental control in the Lab under high-altitude conditions with maximum use of the crew (i.e., "man-in-the-loop").

Final integrated checkout will be performed at the launch pad.

5.3 PRELAUNCH CHECKOUT OPERATIONS

The checkout operations for the basic Phase I Lab are based on the checkout developed in the AES Phase B study (Ref. 5.3), and reflect maximum utilization of currently planned KSC facilities and equipment. The main objective of this Addendum Study effort is to present a preliminary definition of prelaunch operations related to payload integration for the Phase I Labs. Subparagraph 5.3.1 summarizes the experiment test requirements on a per mission basis. Additional information concerning the experiment prelaunch checkout test requirements will be found in Volume IV, Parts 1 through 4 of the study. Subparagraph 5.3.2 presents the prelaunch checkout activities in each KSC facility. The description of these checkout activities deals primarily with the Lab payload.

5.3.1 Checkout Requirements

Figures 5.3-2 through 5.3-5 present experiment prelaunch checkout requirements for Flights 507/511, 509, 214, and 216 respectively. In addition to the specific mission requirements presented in the figures, the overall checkout requirements and operations which are applicable to the Phase I Lab/Payload combination are summarized as follows:

- Electromagnetic compatibility (EMC) of the Phase I Lab/Payload combination will be demonstrated by exercising the Lab subsystems and experiments in their operational modes. This test will be accomplished in a shielded chamber or equivalent facility at the MSOB.
- Integrated Lab/CSM EMC will be demonstrated by exercising the spacecraft subsystems and experiments in their operational modes. This test will be accomplished at the RFSTF.
- Experiments which are located on deployable structures or have deployable structures as part of their system, will be demonstrated to the extent practical in a 1-g environment. Deployment of these structures will demonstrate proper operation of deployment mechanisms, facilitate experiment checkout, and permit proper EMC testing of the Lab/Payload combination.

5.3.2 KSC Operations

The Phase I Lab/Payload flow presented in Figure 5.3-1 indicates the total Lab/Payload operations sequence from arrival as a standard LEM through launch as a Phase I Lab. This represents some departure from previous planning shown in Volumes I and II of this study. The flow of Figure 5.3-1 represents a higher level of coordination between the KSC manufacturing operations and the checkout operations. While this has a small effect on overall span time, it represents a more efficient operation.

The functions shown in Figure 5.3-1 as cross-hatched areas are discussed under the modification operations presented in Paragraph 4.3. The checkout functions are discussed in sequence below.

5.3.2.1 Assumptions

The following assumptions are pertinent to the Phase I Lab prelaunch checkout operations:

- LEM has not been cycled through any part of the KSC prelaunch checkout flow before the modification period.
- Individual experiments will have been bench-checked prior to installation in the spacecraft.
- All modification kits, compatibility packages, and experiments have been installed in the spacecraft before integrated testing.

5.3.2.2 Hypergolic Test Building (HTB)

The fluid sections of the Reaction Control Subsystem (RCS) and Thermal Control Section (TCS) of the Environmental Control Subsystem located in both stages will be checked out in the HTB east and west cells. Proof pressure, leakage, functional, and operational checks will be conducted using referee or inert fluids.

Interface checks between AMU (or substitute) and supply system will be conducted. After installation, interface checks will be made between vehicle and supply system.

5.3.2.3 Manned Space Operations Building (MSOB)

While the Lab descent stage is checked for proper mechanical fit with the SLA, the Lab ascent stage and CM will be checked for proper mechanical fit in the docked configuration. After mating of the Lab ascent and descent stages on the polarity fixture and interstage leak checks, the required alignment of experiments and Lab subsystems will be performed.

The primary payload checkout will be accomplished in the MSOB at the same time that the Lab subsystems are being checked out. Basically, this checkout will consist of an end-to-end functional check of each experiment.

Cameras used in the experiments will undergo operational-parameters checks*, whereby shutter control, focus control, film advance, and aperture control will be verified.

A controlled magnetic environment will be required for the magnetometer experiment checkout. The functional checkout of this experiment is discussed subsequently under EMC checkout.

An integrated system checkout will be required to verify the ability of experiments and subsystems to perform as a total system. This system checkout will include four tasks: two are performed under standard sea-level and non-shielded EMI conditions, one under sea-level EMI shielded conditions, and the fourth under simulated high-altitude conditions. These tasks are defined as follows:

- Integrated System Checkout: The complete Lab electrical/electronics system, including experiments, will be operated through all modes of operation. The object of this test will be to demonstrate overall system compatibility.
- EMC Checkout: A vehicle "plugs-out" EMC check will be performed in a shielded chamber in the MSOB. The controlled EMI environment of the shielded chamber will permit the verification of the Lab as a system (subsystem/experiment EMC). The controlled EMI environment of the shielded chamber will also permit the functional checkout of the magnetometer experiment. A magnetic field will be generated within the chamber to stimulate the magnetometer. By monitoring the response of the experiment to the stimuli, a demonstration of its performance in the spacecraft will be obtained.
- Mission Oriented Checkout: In this part of the Lab integrated system checkout, the particular mission modes and operations will be verified in a "plugs-out" configuration. Maximum use will be made of the "man-in-the-loop" during the mission oriented test sequences.

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* Operational parameters provide a measure of system operation, performance, or condition.

- Altitude Chamber Tests: Altitude tests with "man-in-the-loop" will be conducted to demonstrate the capability of the Lab and experiment environmental control sections to function under simulated mission loads and environment. Crew provisions and functions, airlocks and spacesuit functions associated with the EVA experiments will be checked to the extent possible while the Lab is under altitude conditions.

During the course of the spacecraft checkout in the altitude chamber, the expandable airlock will be deployed for ingress-egress operations after which the airlock will be retracted.

Upon completion of checkout at the RFSTF (subparagraph 5.3.2.4) and weight and cg determination in the Pyrotechnic Installation Building (subparagraph 5.3.2.5), the Lab is returned to the MSOB for mating with the SLA.

5.3.2.4 RF Systems Test Facility (RFSTF)

At the RFSTF, an end-to-end Lab Communications Subsystem-MSFN checkout will be performed. The Lab S-Band antenna and the Abort Guidance Section (AGS) will be functionally checked.

The capability to radiate at the RFSTF will be utilized in a Lab/CSM compatibility test. The object of this test is to verify that the Lab and CSM radiative devices do not cause undesirable interaction or other equipment anomalies when both the Lab and CSM are operated together.

5.3.2.5 Pyrotechnics Installation Building (PIB)

After the RFSTF checks are completed, the vehicle will be transported to the Pyrotechnic Installation Building where the equipment necessary to weigh the Lab and determine its cg is located. Non-flight hardware will be removed and flight hardware installation will be completed before the cg is determined.

5.3.2.6 Launch Complex

5.3.2.6.1 Vehicle Assembly Building (Saturn V only). After installation of the LEM Lab in the SLA and mating with the CSM are accomplished in the MSOB, the spacecraft will be stacked on the launch vehicle in the VAB. No experiment checkout is planned while the spacecraft is in the VAB.

5.3.2.6.2 Launch Pad (Saturn IB & V). At the Launch Pad, both the LEM Lab subsystems and experiments will undergo final checkout. Those experiments that cannot be functionally checked out because the spacecraft is in the stacked configuration will be checked by verifying the experiment operational parameters. Required experiment final servicing (camera film loading, etc.) will be accomplished prior to LEM Lab cabin closeout.

5.4 PAYLOAD SUPPORT REQUIREMENTS SUMMARY

5.4.1 GSE Requirements

The GSE requirements for the prelaunch checkout operations associated with particular Phase I Lab experiments have been presented in Volume IV, Parts 1 through 4, under the respective experiment definitions.

In addition to the above-mentioned particular experiment GSE requirements, the following general requirements exist:

- Thermal control GSE will be required during the checkout of those experiment assemblies located on the actively cooled experiment modules.
- Thermal control of the passively cooled experiment during prelaunch checkout may be required on an individual basis.
- Support fixtures will be required for the support of vehicle deployable structures during prelaunch checkout.

5.4.2 ACE-S/C Utilization

Consistent with the Apollo Program, ACE-S/C will be employed as the primary means of Lab/Payload checkout. Adaptability between ACE-S/C and experiment checkout will depend largely upon consideration given to the inclusion of ACE-S/C checkout capability into the design of the experiment.

The following ground rules were utilized in developing the ACE-S/C requirements for Lab/Payload prelaunch checkout:

- ACE-S/C will be utilized wherever feasible.
- Each vehicle will have its own set of carry-on equipment.
- ACE-S/C can support integrated subsystem/experiment testing simultaneously.
- Capability of switching ACE-S/C support to one or a group of experiments to maximize usage is considered feasible.
- Initially, the fourth link to the interleaver will be utilized for experiment checkout.
- Duplication of measurements or displays will be minimized.
- Frequency response and bit rate of monitored signal is a major factor in determining ACE-S/C utilization.

Some of the Lab experiments as currently defined lend themselves partially or totally to ACE-S/C checkout, whereas others are basically not compatible with ACE-S/C checkout. The category definitions given below apply to experiment functional type tests rather than fault isolation tests. ACE-S/C will be used for fault isolation by providing compatible test points; however, ACE-S/C utilization for fault isolation was not analyzed at this time due to the lack of detailed experiment design data. The ACE-S/C utilization definitions are:

- Readily Adaptable to ACE-S/C - Experiments readily adaptable to ACE-S/C are defined as those experiments that lend themselves to ACE-S/C stimuli control, ACE-S/C monitoring or both.
- Partially Adaptable to ACE-S/C - Experiments partially adaptable to ACE-S/C are defined as those experiments that lend themselves to ACE-S/C stimuli control or monitoring but would, in addition, require other non-ACE-S/C compatible ground checkout equipment.
- Not Readily Adaptable to ACE-S/C - Experiments not readily adaptable to ACE-S/C are defined as those experiments that do not lend themselves to ACE-S/C stimuli control or monitoring.

Figure 5.4-1 categorizes the degree of ACE-S/C utilization for experiment checkout of all the Phase I Labs with respect to the definitions and ground rules cited above. Indicated in the figure are the current experiment assignments to each mission and a summary of the ACE-S/C utilization in experiment checkout. As the experiment designs progress, ACE-S/C utilization should be continuously monitored to insure that Payload and Spacecraft checkout requirements are compatible.

5.4.3 Facility Requirements

Prelaunch checkout facility requirements are the same as presented in Ref. 5.3, except that the integration of manufacturing and checkout activities, as shown in Figure 5.3-1, indicates the modification area to be in the MSOB. Determination of weight and cg will be accomplished in the PIB.

The determination of weight and cg for the integrated LEM Lab is shown to be accomplished in the PIB since the capability for this function exists in this facility.

5.5 MISSION OPERATIONS

The prime purpose of the AES missions is to: conduct experiments for basic scientific research, develop and qualify new systems and subsystems, show spacecraft and crew capability to withstand long-duration missions, and to develop space operating procedures and techniques. Instead of performing special flight development missions, the Phase I Lab Program will utilize the Prerequisite Apollo Program flight development, a comprehensive Ground Development Test Program, and a series of flight test objectives incorporated within the flight operations of each type of AES mission to relieve AES flight constraints. The flight test objectives on a per flight basis are presented in Figures 5.5-1 through 5.5-5. These figures also include the methods of achieving the objectives, the crew requirements, the time requirements, and any additional requirements that may be needed. This analysis shows these objectives are mainly passive in terms of crew participation, and thus do not require special spacecraft maneuvering or time-line scheduling. However, they should be noted in the final mission time-line for each flight to indicate that they are being satisfied.

The objectives shown are based on the current AES flight schedule sequence, i.e., Flight 507 precedes 509, 214, 511, and 216. Flight 507 (Figure 5.5-1), therefore, contains objectives that are prerequisites for the other flights. Flight 214 contains objectives that are prerequisites for Flight 216.

The Mission Operations Section of Ref. 5.3 presents the flight test requirements in terms of test objectives and rationale for each type of Phase I Lab mission.

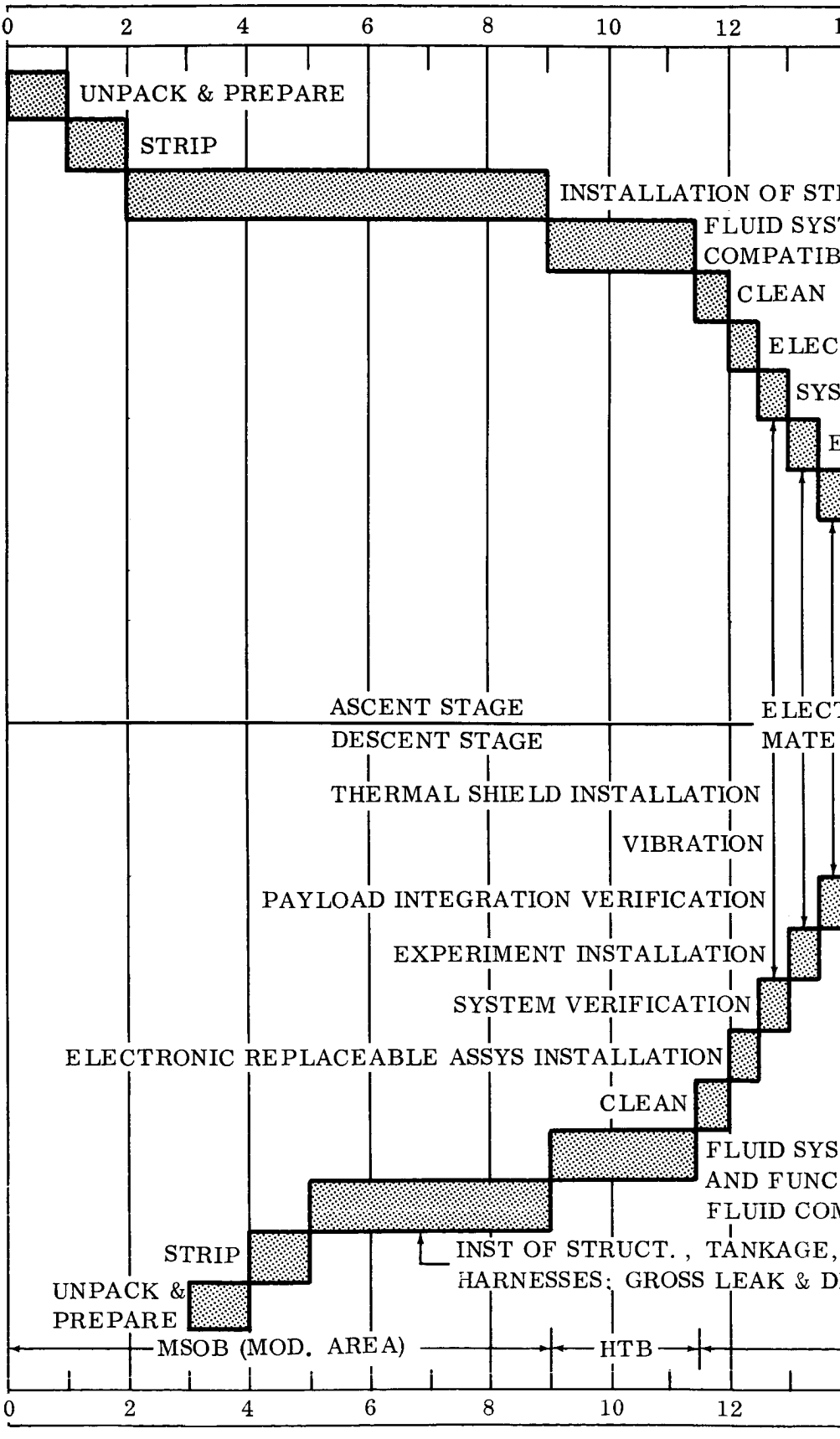
5.6 REFERENCES

The following documents are referenced in this Section:

5.1 Grumman Report; LPL 610-3C, "Lunar Excursion Module Ground Operations Requirements Plan", June 1965.

5.2 Grumman AES-LEM Phase B Final Report, "Phase I Laboratory Design Analysis Summary", Vol. III, 8 Dec 1965.

5.3 Grumman AES-LEM Phase B Final Report, "Prelaunch and Mission Operations", Vol. XVI, 8 Dec 1965.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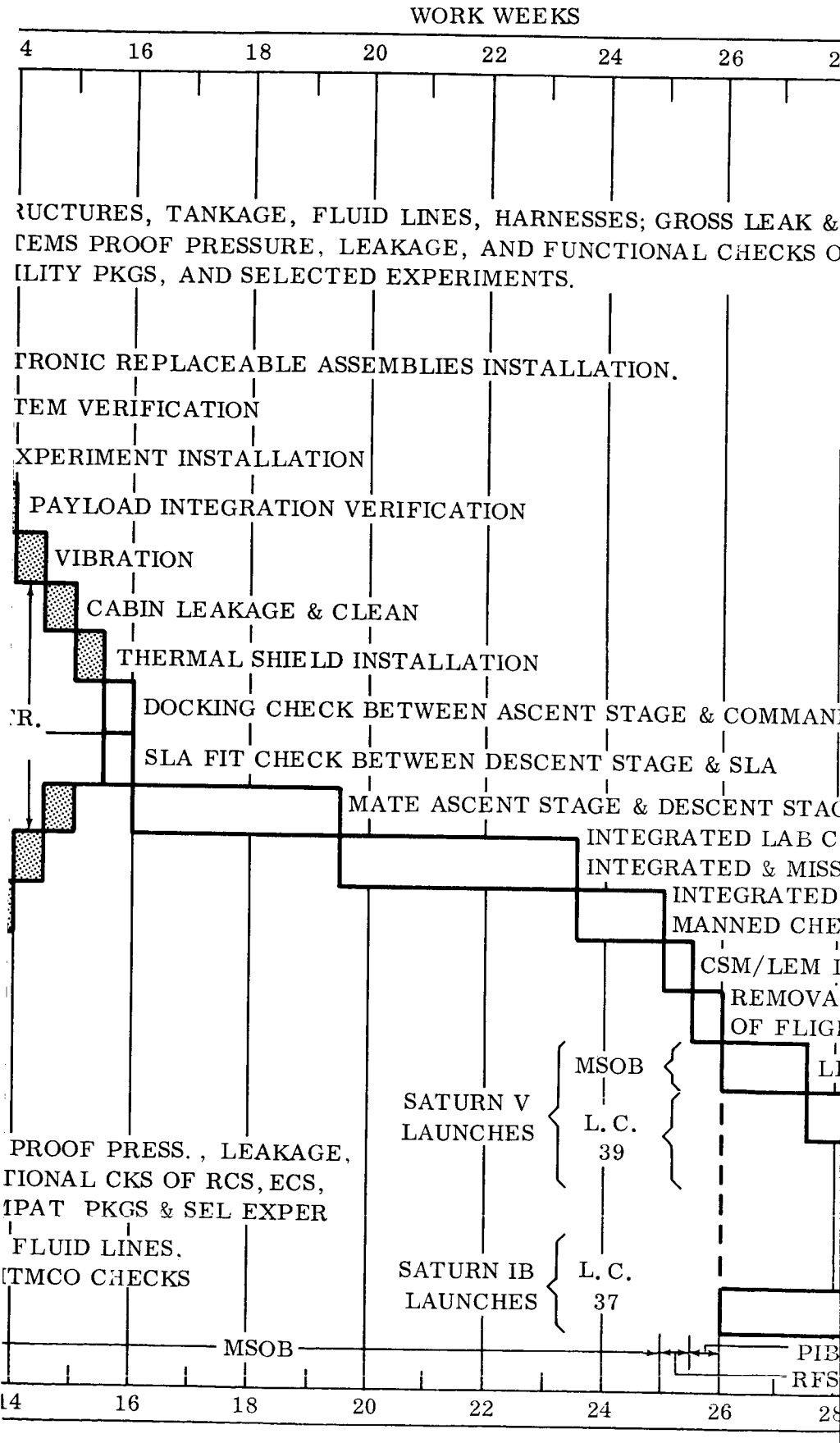
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TEMS PROOF PRESSURE, LEAKAGE, AND FUNCTIONAL CHECKS O
ILITY PKGS, AND SELECTED EXPERIMENTS.
TRONIC REPLACEABLE ASSEMBLIES INSTALLATION.
TEM VERIFICATION
XPERIMENT INSTALLATION
PAYLOAD INTEGRATION VERIFICATION
VIBRATION
CABIN LEAKAGE & CLEAN
THERMAL SHIELD INSTALLATION
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SLA FIT CHECK BETWEEN DESCENT STAGE & SLA
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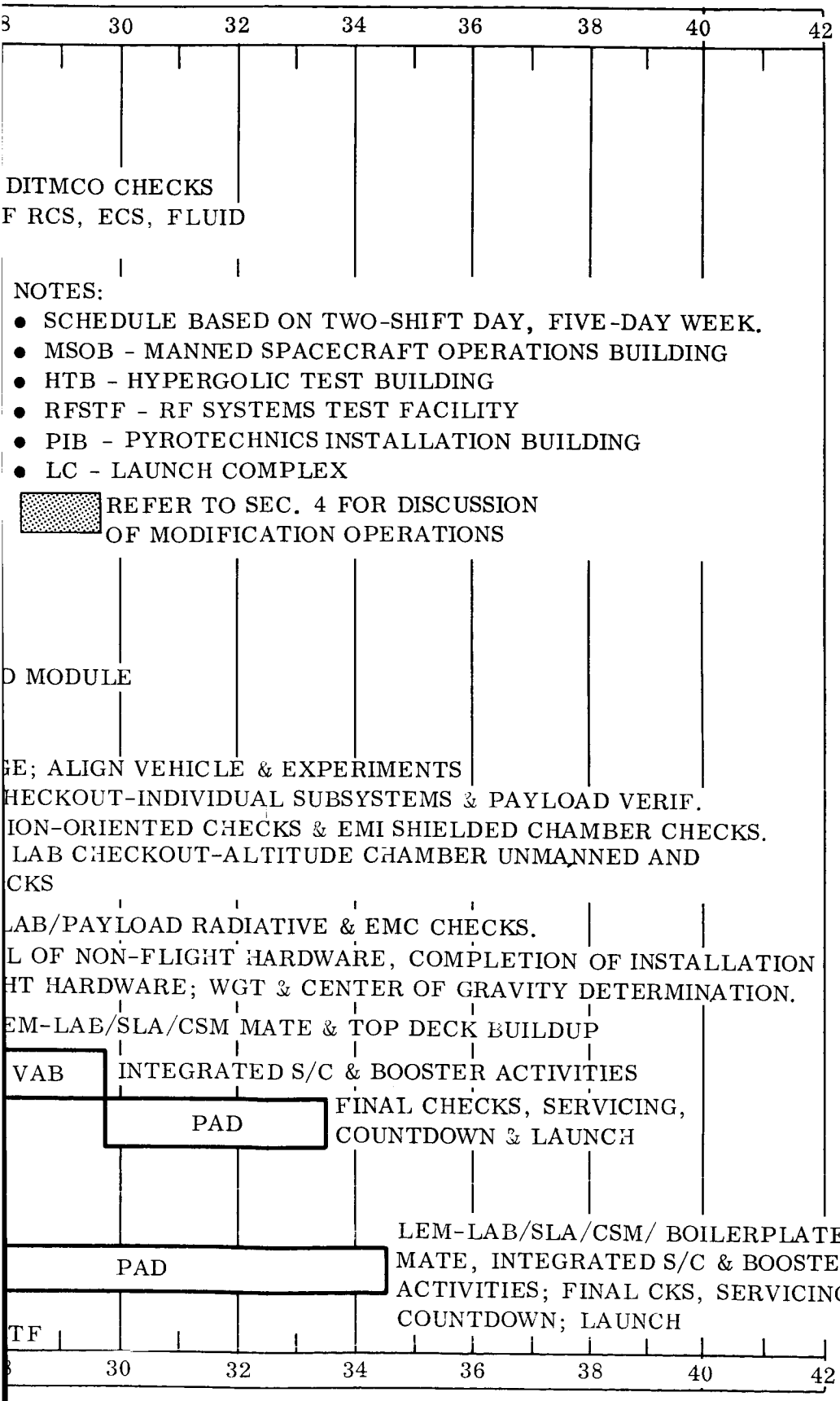

Figure 5.3-1 Modification & Checkout of Phase I Lab at KSC

FLIGHT 507/511 PAYLOAD PRELAUNCH CHECKOUT

EXPERIMENTS	HTB	MS	
		Alignment	Calibration
Radiation Monitoring	The experiments as presently defined for the 507/511 mission will not require HTB checkout.	X	X
Magnetometer		X	X
IR Surveying		X	X
Remote Geochemical Sensing		X	X
Ultraviolet Absorption and Luminescence		X	
X-Ray Fluorescence		X	X
Gamma-Ray Mapping		X	X
Detection of Alpha Emission		X	X
Passive Microwave		X	X
RF Reflectivity Measurements			X
Radar Imaging, Altimetry and Surface State		X	X
Micrometeorite Detection/Collection			
Lunar Gravity Measurement		X	
Lunar Surface Probes		X	
Photographic Investigation 2		X	
Photographic Investigation 3		X	
Viewfinder		X	X

5-3-2-1

T REQUIREMENTS SUMMARY

KSC FACILITY						
OB		RFSTF	Launch Complex 39			
Operational Parameter	Functional C/O		Calibration	Operational Parameter	Functional C/O	Servicing
X	X			X	X	
X	X			X		
X	X		X	X	X	
X	X		X	X	X	
X				X		X
X	X		X	X	X	
X	X		X	X	X	
X	X		X		X	
X	X	X		X	X	
X	X	X	X	X	X	
X	X	X	X	X	X	
	X				X	
X	X			X		
X	X			X	X	X
X				X		X
X				X		X
X	X			X		

(Lab/CSM Compatibility Tests)

Figure 5.3-2 Flight 507/511 Payload Pre-launch Checkout Requirements Summary

FLIGHT 509 PAYLOAD PRELAUNCH

EXPERIMENTS	HTB
Radiation Monitoring Magnetometer X-Ray Astronomy Martian Atmosphere Artificial Comets UV Astronomy Radio Astronomy Small Maneuvering Satellite Propellant Handling Techniques (Phase I) Extendible Rod Performance Test	The experiments as presently defined for the 509 mission will not require HTB checkout.

CHECKOUT REQUIREMENTS SUMMARY

KSC FACILITY								
MSOB				RFSTF	Launch Complex 39			
Alignment	Calibration	Operational Parameter	Functional C/O		Calibration	Operational Parameter	Functional C/O	Servicing
X	X	X	X	Lab/CSM Compatibility Tests		X	X	
X	X	X	X			X		
X	X	X	X		X	X	X	
X	X	X	X			X	X	
X		X	X			X		X
X	X	X	X			X	X	
	X	X	X			X	X	
X		X	X			X	X	X
		X	X			X		X
			X				X	

Figure 5.3-3 Flight 509 Payload Prelaunch Checkout Requirement Summary

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FLIGHT 214 PAYLOAD PRELAUNCH

EXPERIMENTS	HTB		
	Exp. Assembly Checkout	Functional C/O	Operational Parameters
Radiation Monitoring			
Magnetometer			
Control Moment Gyro			
Optical Guidance System			
Deployment of RF Structures			
On-Board G&N Systems			
Orbital Maneuvering and Docking			
Propellant Handling Techniques			
Phase II	X	X	X
Phase III	X	X	X

H CHECKOUT REQUIREMENTS SUMMARY

KSC FACILITY										
	MSOB					RFSTF		Launch Complex 37B		
Servicing	Alignment	Calibration	Operational Parameter	Functional C/O	Servicing	Functional Operational Check		Operational Parameter	Functional Checkout	Servicing
	X	X	X	X		(Lab/CSM Compatibility Tests)		X	X	
	X	X	X	X				X	X	
	X		X	X				X	X	
	X		X	X			X	X	X	
	X		X	X			X	X	X	
	X		X	X			X	X	X	X
X					X					X
X					X					X

Figure 5.3-4 Flight 214 Payload Prelaunch Checkout Requirements Summary

FLIGHT 216 PAYLOAD PRELAU

EXPERIMENTS	HTB		
	Exp. Assembly Checkout	Functional C/O	Operational
Radiation Monitoring			
Magnetometer			
Capillarity Studies			
Evaluation of Spacesuits			
Manned Locomotion & Maneuvering			
Energency Techniques for Rescue			
Personnel & Cargo Transfer			
Propellant Handling (Phase II)	X	X	X
Expandable Airlock			
Extendible Rod Performance Test			

NCH CHECKOUT REQUIREMENTS SUMMARY

KSC FACILITY										
		MSOB				RFSTF	Launch Complex 37B			
Parameter	Servicing	Alignment	Calibration	Operational Parameter	Functional C/O		Calibration	Operational Parameter	Functional C/O	Servicing
		X	X	X	X			X	X	
		X	X	X	X			X	X	
		X		X	X			X		X
		X		X	X			X		
		X		X	X			X		
		X		X	X			X		
		X		X	X			X		
	X									X
					X	(Lab/CSM Compatibility Test)				X
					X				X	

Figure 5.3-5 Flight 216 Payload Prelaunch Checkout Requirement Summary

PRELIMINARY ACE/SC EXPERIMENT

MISSION	EXPERIMENTS	Radiation Environment Monitoring & Magnetometer	X-Ray Fluorescence	Gamma Ray Mapping	Detection of Alpha Emission	Passive Microwave	Lunar Survey Viewfinder	Lunar Gravity Survey	Infrared Surveying	Remote Geochemical Sensing	Lunar Surface Probes	Photographic Investigations	UV Absorption and Luminescence	RF Reflectivity	Radar Survey	Micrometeorite
	507/511	●	●	●	●	◐	◐	◐	◐	◐	◐	○	○	○	○	○
	509	●														
	214	●														
	216	●														

ACE Utilization

● Readily Adaptable

◐ Partially Adaptable

○ Not Readily Adaptable

5.4-1-1

PRELAUNCH CHECKOUT UTILIZATION

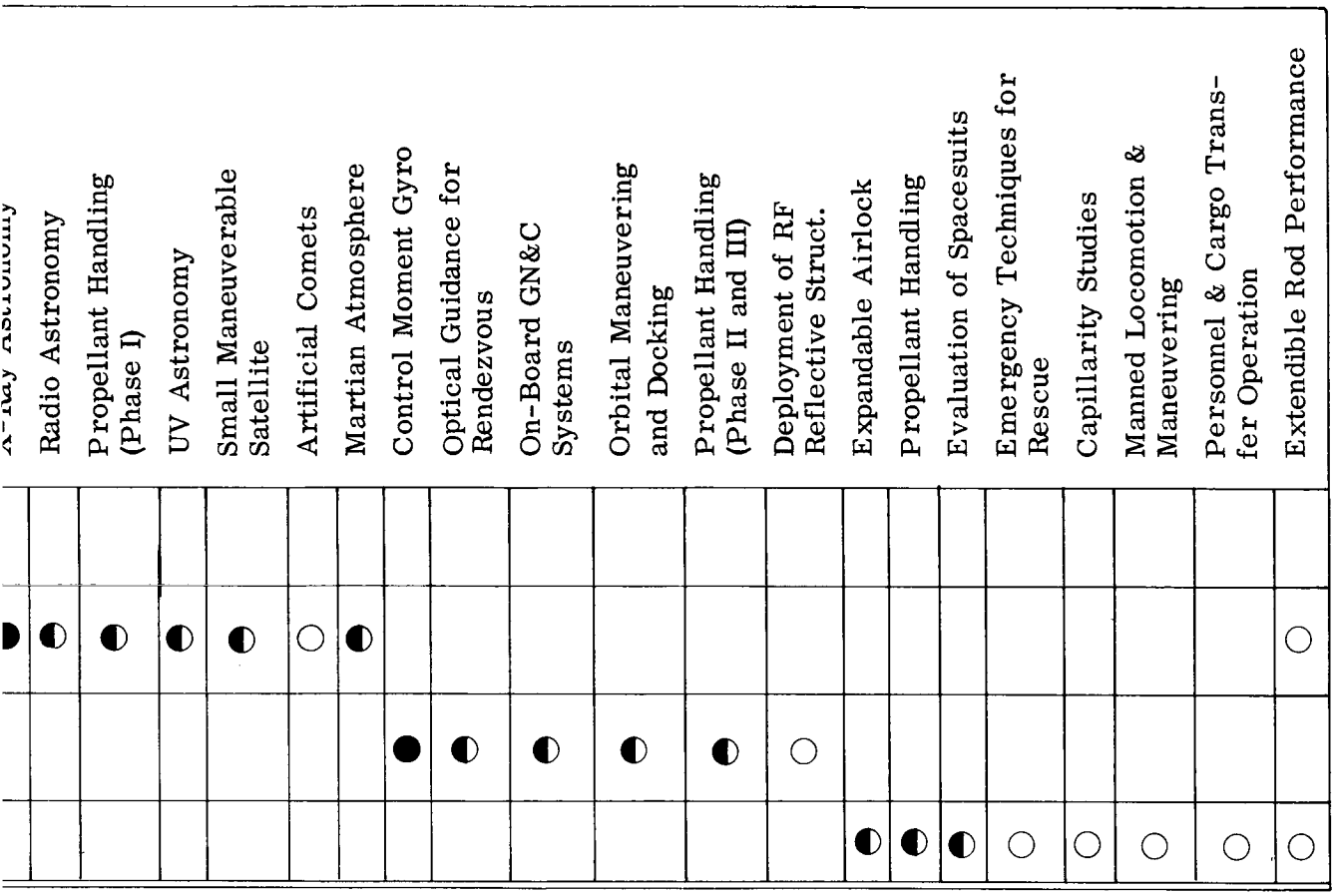

Figure 5.4-1 Preliminary ACE-S/C Experiment Prelaunch Checkout Utilization

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FLIGHT NO. 507
MISSION DESCRIPTION POLAR EARTH ORBIT
ALTITUDE 200 N. MI.
INCLINATION 90 DEG.

FLIGHT 507 TEST OBJECTIVE

OPERATIONAL TEST OBJECTIVE	METHOD OF SATISFYING OBJECTIV
1. Demonstrate compatibility of LEM Lab with MSFN for polar orbit mission operations.	MSFN Capability to support polar orbit mis be verified on the first manned mission of t Off-nominal orbital inclinations and matchi calculated coverage will be determined by n time histories and actual communications c Therefore, no special tests will be needed the required operation of the communicatio
2. Demonstrate the capability of the modified LEM ECS subsystem and crew provisions to support life over a 14 day earth orbital LEM Lab mission	This objective will be accomplished by pe monitoring ECS parameters such as fluid ous inlet and outlet temperatures to see th H_2O management, cooling loop and suit lo eters are within acceptable ranges. Syste able quantities and rates must also be mo special tests or checks will be necessary the present ECS checks. Operational bio will be monitored for a general health che crew.
3. Evaluate the LEM Lab data management systems including instrumentation communications and MSFN/MCC performance in handling experimental data.	This objective will be accomplished by sh large amounts of data can be recorded and when over a ground station. Instrumentat communications systems parameters will tored to differentiate between vehicle syst & ground station failures in the event of a The dual tape recording system will be m satisfactory operation especially during d periods where both recorders are operati neously.

S & EVALUATION CRITERIA

'E	TIME	CREW	ADDITIONAL REQUIREMENTS
;ions must ıat type. g MSFN ıeans of)herence.)ther than ıs subsystem.	Throughout mission duration	0	NONE
'iodically ınd gase- at ARS,)p param- m consum- ıitored. No)ther than ıed data :k of the	Periodic	1-2	Added instrumentation may be required on the new and/or modified ECS equipment and tankage.
)wing that dumped on and be moni- :m failures malfunction.)nitored for .ta dump g simulta-	Periodic - during ground-S/C communications.	1	Additional sensors in the instrumentation & communications subsystems.

Figure 5.5-1 Flight 507 Test Objectives and Evaluation Criteria

FLIGHT NO.: 509
MISSION DESCRIPTION: SYNCHRONOUS E.O.
ALTITUDE 19,350 N. MI.
INCLINATION 0 DEG.

FLIGHT 509 TEST OBJECTIV

OPERATIONAL TEST OBJECTIVE	METHOD OF SATISFYING OBJEC
1. Demonstrate LEM Lab thermal control during synchronous orbit mission profile.	The ability of the ECS system & thermal maintain thermal control of equipments & ment will be verified through the monitor etered data either real-time or hard copy on thermal control of a stable, non-rotati during short periods for experiments will monitoring ECS instrumentation data and equipment temperatures. No special tests of vehicle maneuvers wil
2. Demonstrate the compatibility of LEM Lab with MSFN for synchronous orbit mission operations.	The ability of the MSFN to track, receive data during synchronous orbit operations fied by continuously cross-checking vehic attitude and position information with gro tion. The ability of the ground stations i contact with the Lab during orbital operat the large experiment data load will also b strated. No special tests will be require
3. Evaluate radiation levels throughout mission duration.	Subsystem operating data will be used in with the radiation monitoring experiment determine the effects on electronic compo crew.

5-5-2-1

ES & EVALUATION CRITERIA.

TIVE	TIME	CREW	ADDITIONAL REQUIREMENTS
insulation to cabin environ- ing of telem- . The effects ng vehicle be shown by subsystem	-	-	Additional instrumentation on the Environmental Control Systems
l be required			
and evaluate will be veri- le computed ınd informa- ı constant ions to handle e demon- d.	-	-	NONE
conjunction (0501) to ɔnents and	During LEM/ Lab system checks & experiment 0501	-	Internal spacecraft radiation monitor

Figure 5.5-2 Flight 509 Test Objectives and Evaluation Criteria

FLIGHT NO. 214
MISSION DESCRIPTION EARTH ORBIT RENDEZVOUS
ALTITUDE 200 N. MI.
INCLINATION 28.5 DEG.

FLIGHT 214 TEST OBJECTI

OPERATIONAL TEST OBJECTIVE	METHOD OF SATISFYING OBJECTI
1. Demonstrate integrated mission control from countdown through dual launching, equal period orbit capability, rendezvous and docking.	The Lab will be launched and its subsyst parameters will be monitored to determi formance during orbital storage period. launch, the ability of the MSFN stations vehicles will be shown by cross-checkin vehicle information. No special tests wi to satisfy this objective.
2. Demonstrate the ability of the Lab ECS, EPS, Instrumentation, and Communications equipment to perform as required during unmanned orbital storage period.	During the Lab Earth orbital storage per systems will be periodically monitored. temperatures will show the ECS's coolin ing ability. EPS checks will show power orbital storage. The ability of the comm systems to receive uplink commands wil No special tests will be required.
3. Demonstrate unmanned Lab FCS ability to operate after orbital storage and effect a docking with the CSM.	The FCS system will be activated by gro through the LEM Mission Programmer (input signals to the Lab altitude control e the equipment's output signals will be mo signals to the RCS jets and their resultin parameters will be monitored. No speci be required.

/ES & EVALUATION CRITERIA

/E	TIME	CREW	ADDITIONAL REQUIREMENTS
m and orbital ıe vehicle per- After CSM o dual track the ground and l be required	From Lab countdown to docking	-	NONE
od, the sub- Equipment and/or heat- drain during unications be determined.	Periodically throughout the mission.	-	Additional sensors in the instrumentation and communications subsystems.
nd command LMP). LMP quipment plus nitored. Input ; operational ıl tests will	During rendezvous and docking	-	Input/Output measurements for the AGS.

Figure 5.5-3 Flight 214 Test Objectives and Evaluation Criteria

FLIGHT NO. : 511
MISSION DESCRIPTION: LUNAR ORBIT
ALTITUDE 80 N. MI.
INCLINATION 10 DEG.

FLIGHT 511 TEST OBJECTIV

OPERATIONAL TEST OBJECTIVE	METHOD OF SATISFYING OBJECTIV
1. Evaluate radiation and micrometeorite levels in low inclination lunar orbital environment.	The results of the radiation and micromet toring experiments will be used in conjun parameters of electronic subsystems to d degradation caused by radiation on subsys ance. Biomedical data will show the eff on the Lab crew. No special tests will be
2. Demonstrate CSM/LEM Lab mission compatibility for lunar orbital thermal vacuum environment over mission duration.	The ability of the Lab thermal control and maintain crew comfort will be demonstrat toring system parameters. The ECS and provisions consumable usage rates will be mined. The thermal vacuum effects on st integrity will be shown by monitoring vibr puts to the vehicle equipments from the R

5.5-9.1

ES & EVALUATIONS CRITERIA

'E	TIME	CREW	ADDITIONAL REQUIREMENTS
eorite moni- tion with the etermine the tem perform- ects, if any, required.	During LEM/ Lab system checks & experiment 0501	1	Internal Spacecraft radiation monitor.
ECS to ed by moni- crew deter- ructural ational in- CS.	During LEM/ Lab systems checks plus monitoring	1	Additional instrumentation may be required to obtain data on the ECS systems performance in a lunar environment with modified equipment & added consumables.

Figure 5.5-4 Flight 511 Test Objectives and Evaluation Criteria

FLIGHT NO. 216
MISSION DESCRIPTION EARTH ORBIT RENDEZVOUS
ALTITUDE 200 N. MI.
INCLINATION 28.5 DEG.

FLIGHT 216 TEST OBJECTI

OPERATIONAL TEST OBJECTIVE	METHOD OF SATISFYING OBJECT
1. Demonstrate integrated mission control from countdown through dual launchings equal period orbit capability, rendezvous and docking.	The CSM will be launched first and chec The unmanned LEM Lab will be launche checked out using ground commands to a systems. The ability of the ground stat and control the Lab for CSM active rend ing will be demonstrated by cross-check ground station data. No special tests w to satisfy these objectives.

VES & EVALUATION CRITERIA

IVE	TIME	CREW	ADDITIONAL REQUIREMENTS
ked out in orbit. d and will be ctivate the sub- ions to dual track ezvous and dock- ed vehicle and ll be required	From CSM countdown to docking	--	NONE

Figure 5.5-5 Flight 216 Test Objectives and Evaluation Criteria

6. SUPPORT

6.1 INTRODUCTION

This report indicates the results of the Phase B Addendum Study of the payload/integration ground support efforts relative to the AES Phase I Lab. The ground support study was based upon the following guide lines:

- Feasibility design of the GSE required only to the extent necessary to established budgetary estimates.
- Experiment/payload integration support functions and GSE only for Flights 507, 509, 214, 511, and 216.
- Experiments and their associated bench and acceptance test GSE/STE will be provided as GFE.
- All guide lines except the last one listed in the Phase B Support Plan, Volume XXII, Paragraph 1.5 were applicable to this study.

The support approach for the payload integration effort was based upon the Phase B Support Plan, Volume XXII, of the AES/LEM Program, and expanded the initial Phase B support requirements indicated in the following Phase B study reports:

- Support Equipment Requirements, Volume XXV.
- Training Equipment Requirements, Volume XXIV.
- Transportation Plan, Volume XIII.

These additional support requirements evolve from the flight equipment and vehicle performance and checkout requirements associated with the addition of the compatibility packages and experiments to the baseline Phase I Lab. They are identified in this section.

6.2 INTEGRATED SUPPORT SYSTEMS REQUIREMENTS

The objective of the study was to identify the integrated support systems requirements. The study established the following goals which system equipment should satisfy:

- Integrated support systems should have the capability of performing end-to-end operational tests of the installed experiments with associated compatibility equipment in the basic Phase I Lab.
- Integrated support systems should have the capability of fault isolation at the replaceable black box level during the integrated operational tests.
- For maximum cost effectiveness, the integrated support system equipment should incorporate the GSE of the experiments and baseline Phase I Lab to the maximum feasible extent.

6.2.1 Scope

Engineering analysis of each flight was conducted to determine the classes of functional sets required by the integration task. After determination of classes of functional sets, each functional set class was examined and investigated to

define the functions to be performed by each individual functional set. The results of these studies and analyses developed a list of functions by classes on a per flight basis. Brief summaries of the functional sets for Flights 507/511, 509, 214, and 216 are shown in Figures 6.2-1 through 6.2-4, respectively.

6.2.2 Mechanical GSE

During the Phase B Addendum Study the following areas were investigated for determination of mechanical GSE to support the integration effort for Flights 507/511, 509, 214 and 216:

- Mechanical support equipment requirements for each individual experiment package.
- External flight configurations were examined for required installation fixtures and areas of interference with existing support equipment.
- Internal flight configurations were investigated to determine ease of installation of experiment packages within the cabin area.
- Checkout requirements were reviewed and mechanical support hardware was defined to accomplish the checkout function.
- Alignment requirements for each experiment were identified with the intent of establishing line-of-sight and accuracy requirements for each total flight.
- Areas requiring modification to existing support equipments were investigated and trade-offs between alternate methods of solution were evaluated.

The mechanical handling equipment for each experiment package was determined in accordance with the latest copy of "Human Engineering Design Criteria for Ground Support Equipment", LEM Engineering Document 480-8. For the purpose of this study it was assumed that since the Experimenter would require first use for this equipment, it would be his responsibility to supply the required GSE to support the handling of each experiment package.

External and internal flight configurations were investigated and the preliminary requirements for the need of installation fixtures was determined. After studying several methods of modifying existing GSE to accomplish experiment integration, the following methodical approach was deemed most satisfactory. When existing LEM mechanical support equipment is utilized and a modification is required, a determination as to the most economical manner of effecting the modification was made. An example of the type of modification effort required is the modifications to the existing Ascent Stage and Descent Stage Work Platforms, with respect to all experiments existing for a particular flight. To accomplish this, each quadrant of the workstands was examined for all flights, and the required modifications per quadrant were preliminarily identified so that the flight article can be properly supported. The engineering analysis shows that a quadrant investigation presents a clear, concise picture of the total modification effort, on a per flight basis, for the workstands. It is anticipated that existing equipments would be modified for use, except where there is a cost advantage to build additional modified units or where a serious schedule problem could develop for either LEM or Phase I Labs.

The following mechanical support equipment requires modifications to accommodate the experiment equipments; the list was generated from an analysis of the tentative Phase I Lab configurations during the Addendum study.

- Descent Stage Workstand
- Ascent Stage Workstand
- Chamber A Workstand
- Descent Stage Dolly
- Descent Stage Support Stand
- Descent Stage Transporter
- SLA Platforms
- Integrated Workstand
- Cabin Cleanliness Enclosure

Experiments requiring alignment checks were identified and the final line-of-sight and accuracies of measurement will be determined upon the final location of the experiment, the type and location of the Experimenter supplied Alignment Gage or Bench Mark for his experiment, and the final flight configuration for all experiments of a particular flight.

Final configurations and requirements for the mechanical GSE will be determined during the next phase, as the experiment interfaces and specialized requirements for handling, checkout, and alignment become more clearly defined.

6.3 SUPPORT EQUIPMENT

6.3.1 Scope

This paragraph provides a preliminary definition and summary of the support equipment required by the experiment integration tasks for the Phase I Labs during development, manufacturing, and operational cycles. This discussion does not include Ground Operating Equipment (GOE), Material Support Equipment (Spares), or Training Equipment.

The equipments listed are based on the Manned Space Flight Schedule, ML-65-1, dated 7 August 1965. It should be noted that any re-evaluation of this schedule to reduce the density of launching demand can result in a revision to the Support Equipment Requirements. Re-analysis would be required, however, to determine definitive requirements.

Examination of the experiment integration requirements reveals that certain support equipment can be recycled to subsequent flights. For example, the support equipment required for Flight 511 integration was determined to be identical to Flight 507 requirements; therefore, no additional support equipment has been identified for Flight 511.

6.3.2 Support Equipment Requirement Summary

The following tabulation is a summary of the required GSE, for the experiments, compatibility packages, and integrated system checkout, listed in detail in Appendix A.

TOTAL SUPPORT EQUIPMENT REQUIREMENTS

Required	Design Qty	Units Qty	Supplied
Existing Equipment Design (Common)	246	1469	GFE
Re-Designed or Modified Equipment	52	115	GFE
New Design	251	843	CFE

BREAKOUT OF SUPPORT EQUIPMENT REQUIREMENTS

Required	Design Qty	Units Qty	Supplied
Unmodified LEM Equip	54	888	GFE
Unmodified Baseline Equip	43	128	GFE
Unmodified Experimentor's Equip	144	438	GFE
Additional Equip	5	15	GFE
Modified LEM Equip	11	27	GFE
Modified Baseline Equip	41	88	GFE
New Equipment	251	843	CFE

6.4 GSE FUNCTIONAL CONFIGURATION FOR FLIGHTS 507/511

An important result of the Phase B Addendum Study was the integration effort which combined effectively the ground support equipments with the experiments and compatibility equipments. The various functional requirements were analyzed and reduced to common functional forms. The resulting diagram, Figure 6.4-1, delineates the functional interfaces between the experiments, the compatibility equipment, and the integrated support systems for pre-launch checkout of Flights 507/511.

The diagram displays the complex interlationships existing between the experiment and compatibility equipments, and the integrated support equipments. For clarity, the functional interfaces between the experiments and the compatibility equipments are not included in the diagram; however, these interfaces are available in the

Functional Interface Diagram, Flight 507/511, Volume III. In addition, the diagram does not include all functional interfaces required to isolate malfunctions at the black box level. The addition of these two groups of interfaces on the diagram would prevent a clear presentation of the interface problem.

The diagram also includes a definition of those support functional requirements which are supplied by the experiment contractor. These functions are enclosed by a dotted-line box. A solid line box denotes that the functional equipment is supplied by the integration contractor.

A review of the diagram shows the extent which the experiment support equipment has been included in the integrated support systems. To develop these results, the concept employed was to utilize, to the maximum extent feasible, the equipment which an experimenter would require normally to perform acceptance tests.

To achieve high utilization of the experiment support equipment, the requirements of the integrated support systems should be furnished to the experiment contractor early in the design stage. One method of accomplishing this objective would require the integrator to furnish these requirements to NASA. NASA would review and modify the requirements, and then include them in the RFP package to the experiment prospective contractors. Some method, such as outlined here, would result in maximum cost effectiveness.

6.5 GSE FUNCTIONAL BLOCK DIAGRAMS FOR FLIGHTS 507/511

An analysis was conducted of each experiment and associated compatibility equipment to define the functional requirements to accomplish:

- End-to-end testing
- Fault isolation at the replaceable block box level.

The results of these analyses developed descriptions and functional block diagrams for each experiment and compatibility equipment. Identification of the source responsible for providing the GSE was based on the guideline that the experimenter support equipment used for acceptance tests by the experimenter would be incorporated with the payload integrator's equipment where feasible.

6.5.1 Micrometeorite Collection and Detection

An analysis of the detector operations of the micrometeorite collection and detection experiment indicates that simulation of micrometeoroid parameters is not realistic during the pre-launch checkout phase. The study reveals, however, that the simulation of the output of the sensors should be accomplished. Special stimuli generators are provided for this function. The particle impact on the detector plates is expected to fall in the range of 0 to 1000 per hour, while the particle velocity through the velocity tube is anticipated to be 2 to 15 microseconds. The stimuli generators will provide these input signals and their dynamic ranges to the experiments counter readouts. The checkout of the experiment is initialed by the ACE Carry-on Up-Link which furnishes an enable signal to the special stimuli generators. These generators are sequenced to cover the applicable ranges of the detectors. The functional block diagram is shown in Figure 6.5-1.

6.5.2 Passive Microwave

Pre-launch checkout will be performed on each of the seven major subsystems required to satisfy the objectives of the passive microwave experiment. All GSE required to perform "end-to-end" testing of each subsystem will be housed in environment-free enclosures. Maximum use of the on-site ACE station will determine the pre-launch checkout on a "go" or no-go" basis. An optical alignment check will be made at MSOB to ensure boresight of the antennas with the spacecraft vertical axis.

Space coupling techniques in two ortheogonal planes of polarization will be implemented during checkout operations at MSOB using signal generators calibrated in wave lengths of 21, 7, 3.3, 1.6, 0.8, and 0.4 cm for the spectral channels; and for the image channel the calibration will be at approximately 3 cm (the exact wavelength to be determined at a later date). Input signal levels will be controlled at the source and will be consistent with the dynamic range of each channel. A suitable test connector, located on each component assembly, will be required to facilitate fault isolation. Furthermore, the test connector will be utilized to by-pass integral power controls to supply primary power to the subsystem under test. Functional testing at RFSTF and on the launch pad will require directional couplers, using either coaxial cable or waveguide feed. All parametric data required to establish a "go" or "no-go" condition will be processed into a format acceptable to the ACE Down-Link for comparison and decision. The functional block diagram is shown in Figure 6.5-2.

6.5.3 Panoramic Photography

The pre-launch checkout of this equipment will make use of the Lunar Surface Viewfinder (LSV) for target acquisition and hold as presented by the Illuminated Movable Target (IMT). Since the cameras are remotely controlled, the man in the loop will be utilized. Primary power for remote control of the subject equipment will be derived through the LEM Power Cart to the appropriate EPS bus. A preliminary check of the camera equipment will be performed by exercising the cameras for general functioning. This procedure will require the use of an intervalometer for start and stop sequencing of the picture. After this operation overall camera functioning will be checked. This will be done by utilizing the appropriate selected film and Illuminated Movable Target Simulator. Upon completion of the test the film packs will be retrieved and studied to ascertain that the anticipated resolution has been obtained. The functional block diagram is shown in Figure 6.5.3.

6.5.4 Multispectral Photography

The pre-launch checkout of this equipment will incorporate, essentially, the same procedure as established for the Panoramic Photography Experiment. Initially, the alignment check and experiment assembly verification shall be performed after which the operational parameters (film advance, lens sweep, intervalometer control, and film exposure) will be checked. The Lunar Survey Viewfinder will acquire and track a target as presented by the Illuminated Movable Target. Upon acquisition and tracking of a selected target, the Multispectral Camera equipment, properly syncronized by means of an intervalometer, will be activated. This will require the used of the man-in-the-loop to actuate the required mechanisms. Upon exposure

of the film packs as part of the checkout, interpretation of the results will be made to determine the proper overlap of the four cameras(10 and 60%) and the proper resolution (angular = 44 arcsec). The functional block diagram is shown in Figure 6.5-4.

6.5.5 X-Ray Fluorescence

The end-to-end testing of the X-Ray Fluorescence Experiment is initiated from the ACE Station. The enabling signal is transmitted through the ACE Up-Link to the stimuli contained within the experiment. The output of the experiment detector is transmitted to the ACE Station through the PCM, and is also displayed on the experiment indicator. Verification of the count rate meter operation is accomplished by a pulse generator stimulation, enabled by the ACE Station through ACE Up-Link. Power supply operation is verified by DC monitoring through ACE Down-Link to the ACE Station. The functional block diagram is shown in figure 6.5-5.

6.5.6 Infra-Red Survey

Pre-launch checkout will be performed on each of the the three major subsystems required to satisfy the objectives of the IR survey experiment. All necessary GSE required to perform "end-to-end" testing of each system as a unit, or each major component assembly, will be housed in environment-free enclosures. Operation of the test station will be controlled by inputs obtained from the ACE Up-Link and pertinent measurements. This processed information is then fed into the ACE Down-Link for establishing a "go" or "no-go" condition. An optical alignment check will be made at MSOB to ensure boresight of the IR optics to the spacecraft vertical axis. A suitable test connector, located on each component assembly, is required to facilitate fault isolation. This test connector will be used to by-pass integral power controls to supply primary power to the subsystem under test. Stimuli, calibrated both in wavelength (2 to 20 microns) and intensity, will be used to establish the spectral sensitivity and dynamic range of the experiment equipment. In addition, a sync signal, indicative of the scanning rate, will determine whether compatibility requirements exist between the experiment and the video monitor and data recorder. The functional block diagram is shown in Figure 6.5-6.

6.5.7 Radar Imagery, Altimeters, and Surface State

Pre-launch integrated checkout of the Radar Imaging, Altimeters, and Surface State Experiment is accomplished by a end-to-end functional test which is integrated with the ACE Station. The experiment uses a side-looking coherent imager radar and two radio altimeters, at 400 MHz and 8 GHz, to obtain surface state information. Figure 6.5-7 presents the major checkout equipment with associated interfaces required to perform the checkout of the imager radar and the two altimeters.

The GSE equipment for the imager radar and two altimeters will perform the following functions:

- Generate stimuli signals for the radar and the altimeters at RF and other frequencies.
- Make spectral and other diagnostic measurements on the radar and altimeters.
- Generate programs for control of the radar and altimeters inputs.

The parameters of program-start and PRF of the stimulus GSE will be transmitted to the ACE signal conditioners for monitoring. The GSE interface includes transmission lines for RF and other frequency signals.

The electronics checkout adapters will include line drivers (if required) to convert radar and altimeter electronics assembly GSE signals to a power level and impedance sufficient to prevent loss of information in the transmission lines.

The antenna checkout adapters perform the following functions:

- Couples RF to and from the Radar and Altimeters Antenna Assemblies.
- Protects the Radar and Altimeters Assemblies against damage and contamination.
- Provides free-space impedance to the Radar and Altimeters Transmitters.
- Attenuates the transmitters signals to prevent electromagnetic interference with other Phase I Lab electronics.

The ACE carry-on equipment will include an Event Signal Conditioner, Analog Signal Conditioner, Up-Down Counter, Radar and Altimeter Data Registers, and Digital-to-Pulse Converter. Certain stimulus parameters will be monitored by the Carry-On Signal Conditioners for transmission to the ACE computer which will process data according to the stored program, and produce test results which will be recorded for future analysis. Readouts are also available to the Control Operator for interpretation into procedural decisions.

6.5.8 Ultra-Violet Luminescence

The checkout of the UV Luminescence Experiment will be performed by utilizing a calibrated UV source (1800 to 3000 Å). The stimuli and detector will be housed in a black nitrogen-filled bag to ensure satisfactory operation after the experiment has been installed in the spacecraft at MSOB. The ACE is used to supply the required commands to the controls and to monitor the output of the experiment. The checkout will include the monitoring of the operation of film advance, shutter control, focus control, and aperture control of the experiments camera. The functional block diagram is shown in Figure 6.5-8.

6.5.9 Remote Geochemical Sensing

Pre-launch checkout of the Remote Geochemical Sensing Experiment is accomplished by end-to-end functional test of the experiment, integrated with the ACE Station. Through an up-link adapter, the enabling signals are furnished to the sunlight simulator. The experiment uses the sun as a source of illumination as a reference, and the ground simulator furnishes light to the reflecting sphere in the range of 1500 to 9000 Å. The up-link adapter also furnishes signals to the lunar-light simulator. The experiment monitors the light reflected from the Moon which, when compared with the reference measurements, produces a measurement of vapor concentration. The lunar-light simulator provides selected spectrum stimuli for experiment measurements. The output of the lunar-light simulator will be determined upon completion of experiment definition. The output of the differential amplifier is directed to the ACE Station, after being conditioned by the carry-on down-link adapter. The functional block diagram is shown in Figure 6.5-9.

6.5.10 Lunar Surface Probe

6.5.10.1 Probe Checkout

The pre-launch integrated checkout of the communications equipment in the Probe Support Equipment (installed in the Phase I Lab) of the Lunar Surface Probes Experiment is accomplished by an end-to-end functional test. The communications equipment, involved in addition to the above, are the Capsule Data Transceiver, the Penetrometer Receiver, the LSP Delivery Vehicle Receiver, and the LSPDV Command Transmitter with associated antennas. Figure 6.5-10 shows the major checkout equipment, with associated interfaces, required to perform the checkout.

The signal switching rack routes the inputs and outputs of the communications test stations to the supported items. The rack provides amplification, attenuation, and monitoring of RF signals. The communications test station will perform the following functions:

- Generate stimulus signals for the PSE at RF and other frequencies.
- Make spectral and other diagnostic measurements on the PSE.
- Generate control of the PSE inputs.

The PSE Antenna Checkout Adapters perform the functions:

- Couples RF to and from the PSE Antenna Assemblies.
- Provide free space impedance to the transmitter.
- Attenuates the transmitter signals to prevent electromagnetic interference with other Phase I Lab electronics.

6.5.10.2 Fuel Servicing

Figure 6.5-10, shows the functional block diagram of the GSE required to service and checkout the liquid propellant section of the Lunar Surface Probe.

6.5.11 Lunar Survey Viewfinder

Pre-launch checkout of the Lunar Survey Viewfinder (LSV) is accomplished by performing opto-mechanical and electrical checks. The first check is mechanical in nature to insure the integrity of the unit and its installation on the vehicle. This test will include visual observations and leak checks to determine that there is an adequate rotating seal between the cabin window, LSV outer tube, and through the optical train.

The leak test uses a Helium rich atmosphere in the vicinity of the rotary seal and around the portion of the LSV protruding within the cabin. This seal will be accomplished by use of an inflatable plastic enclosure and a helium sniffer in conjunction with a leak detector (mass spectrometer type) around the rotating seal and the forward end of the LSV (internal). The electromechanical check is performed by activating the unit either electrically, or by means of a proposed manual control. The inputs are applied in a prescribed manner to assure the proper overall functioning of the unit. At the same time the low and high resolution mode capabilities are operative.

The checkout provides assurance of the optical integrity of the unit. To check the resolving power of the LSV in various modes, the standard Air Force Resolution Patterns are used. In the high-resolution mode, the equipment provides an angular resolution of 3.5 to 4 arcsec which, from an 80-n. mi orbital altitude, is equivalent to a ground resolution of 2.5 meters.

As may be observed from Figure 6.5-11, the final system check is accomplished by means of a proposed Illuminated Movable Target Simulator. Target presentations will consist of a number of landmark targets which will move in a manner prescribed by a electronic control input.

6.5.12 Lunar Gravity Survey

Pre-launch checkout of the Lunar Gravity Survey (LGS) Experiment is accomplished by an end-to-end test performed with the ACE-S/C, ACE-Carry-On, signal stimuli, and electronics adapter. The LGS gradiometer system contains two vibrating string accelerometers mounted normal to each other on a biaxial stable platform. An integration check of the accelerometers (in the vehicle) is not feasible because the accelerometers may not be allowed to be uncaged until the vehicle is placed in orbit. A step-response check is performed on the stable platform in roll, pitch, and azimuth to evaluate the systems capability to realign in a specified time. The functional block diagram is shown in Figure 6.5-12.

6.5.13 Radio Frequency Reflectivity

Pre-launch integrated checkout of the RF Reflectivity Experiment is accomplished by an end-to-end functional test performed with the ACE-S/C. The experiment uses a special type of radio altimeter which obtains information from changes in the return pulse shape. Figure 6.5-13 presents the major checkout equipment with associated interfaces for checkout of the radio altimeter.

The Altimeter Section Checkout Station (ASCS) will perform the following functions:

- Generate stimulus signals for the Altimeter at RF and other frequencies.
- Make spectral and diagnostic measurements on the Altimeter.
- Generate programs for control of the Altimeter inputs.

The parameters of program-start and PRF of the stimulus GSE are transmitted from the ASCS to the ACE carry-on signal conditioners for monitoring. The ASCS interface includes transmission lines for RF and other frequency signals.

The Altimeter Electronics Checkout Adapter includes line drivers (if required) to convert Altimeter Electronics Assembly GSE connector signals to a power level and impedance sufficient to prevent loss of information in the transmission lines.

The Altimeter Antenna Checkout Adapter performs the following functions:

- Couples RF to and from the Altimeter Antenna Assembly.
- Protects the Altimeter Assembly against accidental damage or contamination.
- Provides free space impedance to the Altimeter transmitter.
- Attenuates the Altimeter transmitter signals to prevent electromagnetic interference with other Phase I Lab electronics.

The ACE-Carry-On includes an Event Signal Conditioner, Analog Signal Conditioner, Up-Down Counter, Altimeter Data Register, and Digital-to-Pulse Converter. Certain stimulus parameters are monitored by the carry-on signal conditioners for transmission to the ACE Down-Link Computer. The computer processes data, according to the stored program, and the test results recorded for future analysis.

6.5.14 Alpha-Emission from Lunar Surface

The end-to-end test of this experiment is performed by the ACE-S/C, using the alpha source which is contained in the experiment equipment. The output of the experiment is transmitted back to ACE-S/C through the PCM, and is displayed on the experiment indicator. The fault isolation of the alpha-particle detector is accomplished by utilizing the alpha stimuli and routing the detector output to a pulse counter. The pulse counter converts the signal to analog and two event signals are transmitted to the ACE for monitoring. Stimuli are provided to the pulse converter and count rate meter, and the results monitored by ACE. Check of the power supply operation is performed by ACE. The functional block diagram is shown in Figure 6.5-14.

6.5.15 Gamma-Ray Mapping

As shown in Figure 6.5-15, the Gamma-Ray Mapping Experiment end-to-end test is performed by ACE-S/C which provides an enabling signal to the calibrated gamma-ray source. This source is an integral part of the experiment. The ACE-S/C monitors the operation of the experiment from PCM data. Verification of the count rate meter is accomplished by providing a stimuli from the pulse generator, and monitoring the output on the ACE. DC monitoring of the power supply is also performed by the ACE.

6.5.16 Radiation Monitoring

The end-to-end testing is accomplished by a stimuli which is part of the experiment equipment. The ACE monitors the output of the pulse height analyzers and rate meters for proper operation of the radiation equipment. The functional block diagram is contained in Figure 6.5-16. To checkout the replaceable assemblies, the same stimuli is used for the detectors. The pulse counter evaluates the output of the detectors, and converts them to analog and event signals which are supplied to the ACE-S/C. The analog and event signals define the number of pulses of the two events, and indicate proper operation. Indicators are checked by the pulse generator and ACE. Power supply verification is DC via ACE Down-Link.

6.5.17 Magnetometer

The test of the Magnetometer is shown in the functional block diagram, Figure 6.5-17. The ACE-S/C enables a stimuli which produces a magnet field. The experiment senses the magnetic field, and its output is monitored by ACE via the PCM. For individual ERA testing, the Rubidium-vapor sensor receives the same stimuli. A frequency-to-voltage converter is inserted before the time sharing commutator and gate circuitry. An analog voltage is produced which is proportional to the magnetic field and is displayed by the ACE. For the fluxgate sensor, the same stimuli is used, or a constant current may be introduced to the auxiliary fluxgate winding. The ACE enables the current source, and readout is accomplished by the frequency-to-analog converter. The checkout uses a frequency deviation output which is

conditioned into a measurable voltage by the experiment electronics. Checkout of the gate, commutator, and experiment electronics is accomplished by a frequency source which is supplied and displayed by the ACE-S/C. The fluxgate and rubidium oscillators are checked by the frequency-to-voltage converter, and power supply operation is verified by ACE readout.

6.5.18 Photographic Timing Reference

The functional block diagram for the checkout of the Photographic Timing Reference is shown in Figure 6.5-18. The unit is checked by receiving pulses from the PCM which is enabled by the ACE-S/C. Output of the timing reference is monitored by the ACE. The output is available on a separate GSE connector to the timing reference, and its pulses may be read directly. An optical check is accomplished by analyzing a sample film processed by the camera. The results of sample film analysis is indicated by test light indications on film.

6.5.19 Metric Survey Photography

Pre-launch checkout of this equipment requires the following steps:

- Experiment assembly verification to assure proper installation of the equipment.
- Film advance
- Lens sweep
- Intervalometer control

The cameras are checked to ascertain proper alignment prior to the steps outlined above. According to present design, the Metric Survey Photographic experiment will incorporate two cameras: a Cartographic and a Stellar. The Illuminated Movable Target Simulator is utilized to attain predetermined targets, or targets of opportunity (land marks). In addition, a star source or constellation presentation must be utilized to verify the proper operation of the Stellar Camera. The film exposed is interpreted by specialized ground personnel to determine whether the cameras are functioning according to parametric requirements. The experimental equipment will be operated by utilizing a man-in-the-loop. The power required for the remote manual control of the equipment is provided by the AES power cart. The angular resolution of both cameras will be in the 3 to 4 arcsec range, and, if it is required, the angle formed by a landmark line of sight (LLOS), the LOS of the Cartographic Camera, and the Star Line of Sight (SLOS), the LOS of the Stellar Camera, will require an angular accuracy of approximately 10 arcsecs maximum. The functional block diagram is shown in Figure 6.5-19.

6.5.20 Video Monitoring

Pre-launch checkout of the Video Monitoring Unit is initiated by an enable signal via the ACE Up-Link. Sync and video signals furnished by the IR and radar imagery experiments will be supplied by a special test set. End-to-end testing employs a man-in-the-loop to determine the presence of video on the CRT. All other pertinent parametric data will be processed and fed into the ACE Down-Link for comparison and decision. The functional block diagram is contained in Figure 6.5-20.

6.5.21 Timer

The timer test equipment is used for Verification Acceptance Testing (VAT) and Bench Maintenance Testing (BMT) of the Timer. The test equipment will supply power and a timing reference signal to the Timer. It will monitor the timer enabling signals and check timing and interface control parameters. It will be capable of failure isolation within the Timer for maintenance. Figure 6.5-21 shows the functional block diagram.

6.5.22 Horizon Sensor

Pre-launch checkout of the Horizon Sensor is performed as an end-to-end test integrated with the ACE-S/C, ACE-Carry-On, Horizon Simulator, and Horizon Sensor Monitor Panel. The ACE Carry-On, when activated by the ACE Station, provides a path to energize the simulator and sensor panel. Dead band errors of ±0.50 deg in roll and pitch are checked by adjusting the simulator and measuring the output voltage of the sensor electronics.

The Horizon Sensor system provides electrical outputs as a function of spacecraft pitch and roll altitude with respect to Earth local vertical. These outputs are set by the attitude control system. The functional block diagram is shown in Figure 6.5-22.

6.5.23 Signal Conditioner

The Calibration, Verification Acceptance Test (VAT), and Bench Maintenance Test (BMT) for the Signal Conditioner is accomplished at the Spacecraft Instrumentation Test Equipment (SITE) Station. Since the stations available at KSC, MSC, and Grumman Aircraft Engineering Corporation are suitable for checkout, equipment requirements include an adapter cable, patch panel, and the programming of a set of automatic tests. The functional block diagram for the signal conditioner is shown in Figure 6.5-23.

6.5.24 Environmental Control

6.5.24.1 Water Glycol Servicing

This functional set will be used to service and checkout the heat transport loops during all ground tests up to the launch. The functional block diagram is shown in Figure 6.5.24.

6.5.24.2 Water Servicing

This functional set will be used to service and checkout the distilled water supply. The functional block diagram is shown in Figure 6.5.24.

6.5.24.3 Oxygen Servicing

This functional set will be used to service and checkout the gaseous oxygen supply. The functional block diagram is shown in Figure 6.5.24.

6.5.25 Electrical Power

The equipment supporting the Electrical Power System (EPS) compatibility equipment will be identical to the STE/GSE utilized to verify the functional integrity of the basic Phase I Lab. The equipment, for similar functions, at different sites will not be identical because of the availability of GFE power sources and the degree of simulation required at Grumman Aircraft Engineering Corporation, MSC, and KSC facilities. Power sources and vehicle loads will be of two types, namely AC and DC, which connect with the vehicle at interfaces necessitated by the required test. To prevent making-breaking of power and loading connections to the vehicle, relay selector matrices will be utilized. The AC power source at Grumman Aircraft Engineering Corporation will be derived from either the Inverter Simulator (410-8510) or the 400-cycle isolation transformer (410-81070) powered from a centralized facility source. The Inverter Simulator will contain prototype flight inverter and pulse generator to provide AC power during the performance analysis of AC-powered experiments which includes the AC portion of the EPS compatibility equipment. Employment of the simulator will prevent continual use of the flight inverter and provide a valid analysis of the harmonic distortion, amplitude modulation, line drop, noise content, EMI, and frequency and voltage regulation performance of the vehicle AC distribution system due to experiment loading. The isolation transformer is utilized at Grumman Aircraft Engineering Corporation and KSC. At KSC, it is powered from a centralized facility source, the transformer at each launch pad will be powered from either the NAA A14-218 or a GFE Kurz-Root motor generator set. At MSC, the flight inverter will supply the vehicle AC power. Facility AC power will be used for fault isolation. The loading of the vehicle at Grumman Aircraft Engineering Corporation is provided by the Load Simulator (410-82150) which provides substitutes for all Phase I Lab loads. The simulated loads can be applied manually or programmed for mission simulation via a tape programmer. Various sub-routines to simulate the firing of an RCS cluster can also be initiated manually or via a programmer. At KSC and MSC, gross loads in lieu of load simulation are required. These gross loads are resistive and supplied through manual selection within the Battery Checkout Load Bank (410-82100). DC power at Grumman Aircraft Engineering Corporation and MSC will be supplied to the vehicle DC interfaces by the Vehicle Ground Power Supply (410-82140). This power source is controlled and monitored manually or by the ACE. At KSC, GFE units similar to the 410-82140 will provide prime DC power to the vehicle. In addition to the power sources and loading described, the EPS Checkout Controller (410-82090) is required at all sites to provide both stimuli to the control logic within each ECA and isolated power for each battery associated with the verification of a specific control function. The functional block diagram is contained in Figure 6.5-25.

6.5.26 Displays and Controls

The 410-42100-1 Displays and Controls Maintenance Test Station, a multirack LEM end item, is used for Verification Acceptance Testing (VAT) and Bench Maintenance Testing (BMT) of the Phase I Lab Display and Control Panels. With minor modifications and a new set of adapters, the Test Station is capable of compatible concurrent usage by LEM, basic AES vehicles, and AES Display and Control Experiment Compatibility equipments. Analysis of the Display and Control Panels of flights 507/511 indicates that approximately 9 panels are new or modified which necessitates the requirement for about 9 adapters. The functional block diagram is contained in Figure 6.5-26.

6.5.27 ACE Carry-On Equipment

The ACE Carry-On is used for pre-launch checkout of the experiments as the stimulus and response link of the total ACE system. On command of the ACE-S/C, the uplink section of the ACE Carry-On provides the selection and controlled stimulus of experiment equipment. The stimuli may be analog voltages with amplitudes varying from +30 to -30 volts or frequency from DC to 20 cps, current from 0 to 300 milliamperes, or external signals routed through relay closures. The response section of the Carry-On conditions the analog and event type response signals and converts them to a format suitable for transmission to the ACE Ground Station. Analog signals are conditioned to a 0 to +5 volts range and event signals to 0 or +6 volts. Each analog signal is pulse code modulated to an 8-bit digital word format, and 8-event signals are grouped together to form an 8-bit pulse code modulated word. These signals are transmitted serially to the ACE Ground Station through the Interleaver. The functional block diagram is shown in Figure 6.5-27.

6.5.28 Spacecraft Instrumentation Test Equipment (SITE)

The SITE stations available at MSC, KSC, NAA, and Grumman Aircraft Engineering Corporation can be used concurrently by LEM, CSM, AES baseline vehicles, and AES Experiment Integration. For Flights 507/511, the SITE is used for calibration, verification acceptance testing (VAT), and Bench Maintenance Testing (BMT) of ACE-S/C Down-Link assemblies and the Signal Conditioner Compatibility equipment. It is assumed that SITE can supply all analog and digital signals and monitor all outputs. No modification to SITE is anticipated for Experiment Integration. Each new end item tested will require the programming of automatic tests and the design of new adapter cables and patch panels. The functional block diagrams are shown in Figures 6.5-28.

6.6 TRAINING REQUIREMENTS

An initial analysis of the training requirements based on the preliminary definition of the missions, experiments, compatibility equipment, and the integration GSE required was performed during this study. The results of the study indicate that the training of the Flight and Ground Crews is most effectively accomplished by utilizing the baseline Phase I Lab training courses as a foundation, and extending these to include the particular flight configuration training functions. The Training Plan, Phase B Final Report, Volume XXII, Section 6, will be expanded to include this approach during the final definition phase of the Payload/Integration Study.

A preliminary definition of the training equipment requirement for the baseline Phase I Lab was discussed in the AES/LEM Phase B Final Report, Volume XXII, Training Equipment Requirements. This report itemized the following training equipment for the baseline Phase I Lab:

- Mission trainer (using LMS, modified, plus one separate "Trainee Cabin")
- System trainers
    - Integrated Flight Control System
    - Environmental Control System

- o Electric Power System
- o Sequential Flow System
- o Familiarization trainers.

The following paragraphs deal with the impact of the experiments/payload integration on this equipment:

6.6.1 Lab Mission Trainer

The Phase B Final Report recommended time sharing on one of the two LEM Mission Simulators (for the baseline Phase I Lab) to maximize use of Apollo-LEM hardware. Assumptions for this study were:

- LEM Mission Simulators will be available for Phase I Lab crew training on a part-time basis and will not cause any LEM schedule slippage.
- LMS will be available for the required modifications, which are expected to be minimal in respect to LEM downtime.
- Time available for Phase I Lab crew training will be adequate for training the crews manning and supporting the Phase I Lab. This time includes the Mission Simulator downtime required to checkout the computer programs, to checkout the planned flight mission profiles, and for updating, for the various flights.

The training was to be supported by building a separate "Trainee Cabin" simulating the Phase I Lab Cabin, connecting it in parallel with the LEM "Trainee Cabin", and providing the capability of being switched into the LMS complex (computers, operator station, etc). This meant that only one trainer was available for Phase I Lab training on a part time basis, on the condition that Phase I Lab training can only take place when it does not affect LEM schedules.

It is recommended, as a result of studying the proposed experiments, that a total of two "Trainee Cabins" be built, one in parallel with each of the LEM Mission Simulators, to help ensure adequate time for training Phase I Lab flight crews, without affecting LEM schedules, and to handle the large amount of downtime between flights. The addition of the experiments, different for each flight (an average of 11 per flight), will require additional down-time to update the cabin after the previous flight to the configuration for the following flight. The "Trainee Cabin", if only one is built, has to have its configuration changed for Flight 509, then for Flight 214, then back to the original Flight 507 configuration for Flight 511 (since the first and fourth flights contain the same experiments) and finally to the configuration for Flight 216. The down-time would have to include time for modifications to the trainee cabin, checking out the new computer program, checking out the planned flight mission profile, and training the flight crew. Only 1 month is available for accomplishing all of this between Flights 214 and 511.

An additional example of the complexity of the trainer reconfiguration is the Viewfinder Experiments for Flights 507 and 511. The viewfinder is positioned in the cabin window and will require a modification to the visual display equipment with which it interferes. The Lunar Survey Viewfinder appears sufficiently complex, operation wise, to warrant a visual display for training the flight crew for these experiments.

Figure 4-1, Mission Trainer Loading and Figure 4-2, Trainer Crew Loading Summary, of Volume XXIV indicate how AES requirements added to the LEM trainer operations greatly increases the loading problem. It should be noted that the Phase I Lab are more diversified than the LEM Program. The mission objectives are different for each flight, while all of the LEM flights are directed toward the single objective of "landing a man on the moon".

6.6.2 System Trainers

Some modification of the system trainers proposed in Volume XXIV will be required. However, it is anticipated that these changes will be small and not greatly affect this equipment.

6.7 TRANSPORTATION

The transportation plan is based upon the Phase B Final Report, Volume XXIII, Transportation Plan. The basic transportation plan is the same as that described in the above document with the exception of the number of major end items to be transported between Grumman (Bethpage) and the Manned Spacecraft Center (MSC), Houston, Texas.

The following is a listing of the major development test articles, consisting of vehicles, ascent, and/or descent stages, to be transported between MSC and Grumman based upon the Phase I Lab Payload Integration Development Schedule:

- LTA-8, from MSC to Grumman, for modification.
- Flight 507 Ascent and Descent Stages, from Grumman to MSC, for testing and mission support.
- Flight 509 Descent Stage, from Grumman to MSC, for testing and mission support.
- Flight 507 Descent Stage, from MSC to Grumman, for modification.
- Flight 214 Descent Stage, from Grumman to MSC, for testing and mission support.
- Flight 509 Descent Stage, from MSC to Grumman, for modification.
- Flight 216 Ascent and Descent Stages, from Grumman to MSC, for testing and mission support.
- Flight 511 Descent Stage, from Grumman to MSC, for testing and mission support.

FLIGHTS 507/511 SUMMARY OF FUNCTIONAL SET CLASSES

Experiment	Functional Set Class
Radiation Monitoring	Checkout: GSE for monitoring operational parameter tests of commutator, pulse height analyzer, encoder, recording equipment, and astronaut's override feature. GSE calibrated electron source, calibrated Alpha source, and signal generator to provide input stimuli for tests. Handling: GSE to verify alignment of the spectrometer assembly. Servicing: Experiment Film Storage Cabinet, a common-use item, provides proper film storage facilities for films utilized on Phase I Lab operations at KSC.
Magnetometer	Checkout: GSE for monitoring operational parameter tests of power supply and the output of the magnetometer. GSE magnetic field generator for stimuli of magnet sensors. Handling: GSE to verify the alignments of the flux gate magnetometer and the rubidium-vapor magnetometer to Phase I Lab axes. Servicing: Magnetic tape storage is provided by common-use item.
Panoramic Photography	Checkout: GSE for monitoring operational parameter tests of camera exposure, film advance, lens sweep, and intervalometer control. Handling: GSE to verify alignment of cameras. Servicing: Film storage is provided by the common-use experiment Film Storage Cabinet.

Figure 6.2-1 Flights 507/511 Summary of Functional Set Classes (Sheet 1 of 8)

FLIGHTS 507/511 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Experiment	Functional Set Class
Multispectral Photography	Checkout: GSE for monitoring operational parameter tests of camera exposure, film advance, and intervalometer control. Handling: GSE to verify alignment of the multispectral cameras. Servicing: Film storage is provided by the common-use Experiment Film Storage Cabinet.
IR Sensing	Checkout: GSE to verify power supply, signal detection, and signal flow through Imager. GSE calibrated IR source to provide input stimuli. GSE to verify power supply, signal detection, and signal flow through grating spectrometer. GSE to verify power supply, signal detection, and signal flow through interferometer spectrometer. Handling: GSE to verify the alignment of the Imager. GSE to verify the alignment of the grating spectrometer GSE to verify the alignment of the interferometer spectrometer. Servicing: Experiment Magnetic Tape Storage Cabinet, a common-use item, provides proper magnetic tape storage facilities for magnetic tape reels utilized on Phase I Lab operations at KSC. Film storage is provided by the common-use Experiment Film Storage Cabinet.
Passive Microwave	Checkout: GSE for monitoring operational parameter tests for power supply, receiver operations, output to Kelvar recorder, and recorder operation for the imaging experiment.

Figure 6.2-1 Flights 507/511 Summary of Functional Classes (Sheet 2 of 8)

FLIGHTS 507/511 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Experiment	Functional Set Class
Passive Microwave (cont.)	GSE special signal generator for imaging stimuli. GSE for operational parameter tests for power supply, receiver operation, output of data format of converter, and antenna slew operation of the spectral measurement equipment. GSE special signal generator to provide stimuli for spectral measurement equipment. Handling: GSE to verify the alignment of the spectral measurement antenna. Servicing: Film storage and magnetic tape storage are provided by the common-use Experiment Film Storage Cabinet and the Experiment Magnetic Tape Storage Cabinet.
RF Reflectivity	Checkout: GSE for monitoring operational parameter tests of power supply, output pulse, receiver processor output, and data format converter output. GSE RF energy absorbing device for antenna measurements. GSE stimuli generator for receiver processor. Servicing: Magnetic Tape storage is provided by the common-use Experiment Magnetic Tape Storage Cabinet.
Radar Imaging and Altimetry	Checkout: GSE for monitoring operational parameter tests of power supply, transmitter output, and receiver output. GSE special stimuli generator to provide input to the Coherent Imager. GSE RF energy absorbing device for side-looking radar antenna.

Figure 6.2-1 Flights 507/511 Summary of Functional Classes (Sheet 3 of 8)

FLIGHTS 507/511 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Experiment	Functional Set Class
Radar Imaging and Altimetry (cont)	GSE for operational parameter tests of power supply, transmitter output, and receiver output of Altimeters. GSE special stimuli generator for Altimeters. GSE RF energy absorbing devices for altimeter antennas. GSE retardation calibration equipment for altimeters. Handling: GSE to verify alignment of coherent imager. GSE to verify alignment of altimeters. Servicing: Film storage and magnetic tape storage is provided by common-use items.
UV Absorption	Checkout: GSE for monitoring operational parameter tests of film advance, shutter control, focus control, and aperture control of the camera. Handling: GSE to verify alignment of the camera. Servicing: Film storage is provided by common-use item.
X-Ray Fluorescence	Checkout: GSE for monitoring operational parameter tests of power supply of lunar X-ray equipment. GSE for monitoring operational parameter tests of power supply and moveable platform of solar X-ray equipment. GSE calibrated X-ray sources to provide input stimuli. GSE moveable collimated light source for input stimuli. Handling: GSE to verify alignment of lunar X-ray detector. Servicing: Magnetic tape storage is provided by common-use item.

Figure 6.2-1 Flights 507/511 Summary of Functional Classes (Sheet 4 of 8)

FLIGHT 507/511 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Experiment	Functional Set Class
Remote Geochemical Sensing	Checkout: GSE for monitoring operational parameter tests of power supply and output of differential amplifier. GSE calibrated light sources for input stimuli. Handling: GSE to verify alignment of ceramic reflecting sphere and scanning head. Servicing: Magnetic tape storage is provided by common-use item.
Micrometeorite Experiment	Checkout: GSE special stimuli generator for simulation of detector outputs to test display equipments.
Lunar Gravity Survey	Checkout: GSE for monitoring operational parameter tests of power supply, stable platform pointing, drift rate, and accelerometer alignment. GSE special stimuli generator for simulation of external roll data. Handling: GSE to verify alignment of stable platform.
Alpha-Emission Detection	Checkout: GSE for monitoring operational parameter tests of power supply and output of pulse converter. GSE calibrated alpha-particle source to stimulate the detector head assembly. Handling: GSE to verify the alignment of the detector head assembly. Servicing: Magnetic tape storage is provided by common-use item.
Gamma-Ray Mapping	Checkout: GSE for monitoring operational parameter tests of power supply and output of gamma-ray telescope. GSE calibrated gamma-ray source to stimulate the gamma-ray telescope.

Figure 6.2-1 Flights 507/511 Summary of Functional Classes (Sheet 5 of 8)

FLIGHT 507/511 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Experiment	Functional Set Class
Gamma-Ray Mapping (cont)	Handling: GSE to verify the alignment of the telescope. Servicing: Magnetic tape storage is provided by common-use item.
Lunar Surface Probes	Checkout: GSE for monitoring operational parameter tests of power supply, Lab I - LSP communication command link, LSP Control Console, Umbilical data transmissions, LSP Data Storage, and RF compatibility. GSE mass simulator of LSP for conducting probe ejection test. GSE probe simulator for conducting experiment simulation from pre-launch check through Lab I re-transmission to Earth of LSP transmitted data. Handling: GSE to verify alignment of LSP on D/S. Servicing: Magnetic tape storage is provided by common-use item.
Lunar Survey Viewfinder	Checkout: GSE for monitoring operational parameter tests of power supply, open-loop tracking, manual operation, and camera operation. GSE optical targets for viewfinder stimuli. Handling: GSE to verify the optical alignment of the viewfinder. Servicing: Film storage is provided by common-use item.
Compatibility Equipment	**Functional Set Class**
Photographic Time Reference	Checkout: GSE stimuli generator for input signals. GSE to check operations of timing reference. ACE Up-link and Down-Link adapters for ACE interface connections.

Figure 6.2-1 Flights 507/511 Summary of Functional Classes (Sheet 6 of 8)

FLIGHT 507/511 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Compatibility Equipment	Functional Set Class
Metric Survey Photography	Checkout: GSE illuminated moveable target to provide stimuli for cameras. GSE to test operational parameters of cameras for exposure, film advance, and remote controls. Handling: GSE to align cameras with spacecraft axes. Servicing: Film storage is provided by common-use item.
Video Monitoring	Checkout: GSE input signal generator to provide stimuli for operational tests. GSE output monitoring equipment to perform functional tests. ACE Up-link adapter
Timer	Checkout: GSE output monitor to perform functional test. GSE bench test equipment to provide stimuli and monitor output signals for operational tests.
Horizon Sensor	Checkout: GSE calibrated IR source to provide stimuli for functional tests. GSE to perform functional tests. Handling: GSE to align scanning head to spacecraft axes.
Signal Conditioners	Checkout: Spacecraft Instrumentation Test Equipment (410-92405) (SITE) SITE adapter set for interface connection.
Environmental Control	Checkout: GSE to perform leak and pressure tests of glycol loops and associated water system. GSE to perform operational parameters bench tests of components of glycol loops and associate water system.

Figure 6.2-1 Flights 507/511 Summary of Functional Classes (Sheet 7 of 8)

FLIGHT 507/511 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Compatibility Equipment	Functional Set Class
Environmental Control (cont)	Servicing: GSE to flush, purge, evacuate, and supply fluids, and to supply glycol cooling during ground tests. Auxiliary: GSE and auxiliary tools to connect support equipment with environmental control compatibility equipment.
Electrical Power	Checkout: GSE for providing power, loading, and control stimuli for verification of EPS compatibility package distribution system. Servicing: GSE for battery activation.
Control & Displays	Checkout: D&C Maintenance Test Station (410-42100-1) and adapter for functional tests.

Figure 6.2-1 Flights 507/511 Summary of Functional Classes (Sheet 8 of8)

FLIGHT 509 SUMMARY OF FUNCTIONAL SET CLASSES

Experiment	Functional Set Class
Radiation Monitoring	Checkout, Handling, and Servicing: Same as Flights 507/511.
X-ray Astronomy	Checkout: GSE for monitoring operational parameter tests of power supply, star sensor, and output of X-ray camera. GSE calibrated X-ray source for stimuli of X-ray camera. GSE calibrated light source for star sensor. Handling: GSE to verify alignment of X-ray camera and stabilized platform. GSE to verify alignment of star sensor. Servicing: Magnetic tape storage is provided by common-use item.
Martian Atmosphere	Checkout: GSE for monitoring operational parameter tests of power supply and the output of the pulse code conditioning assembly. GSE calibrated UV source for stimuli of spectrometer. GSE nitrogen pressure enclosure to house the UV source and spectrometer. GSE for monitoring operational parameter tests of the error sensor. Handling: GSE to verify the alignment of the spectrometer. Servicing: Magnetic tape storage is provided by common-use item.
Artificial Comets	Checkout: GSE to observe the pressure and fluid flow rate of the cloud generator. GSE to perform chemical leak detection tests of the chemical canister.

Figure 6.2-2. Flight 509 Summary of Functional Set Classes
(Sheet 1 of 5)

FLIGHT 509 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Experiment	Functional Set Class
Artificial Comets (cont)	Handling: GSE to verify the alignment of the cloud generator. Servicing: GSE to supply chemicals to the cloud generator.
Far UV Image Converter	Checkout: GSE for monitoring operational parameter tests of power supply and output of image converter. GSE UV source for stimuli or image converter. GSE nitrogen pressure enclosure to house the UV source and far UV optics. Handling: GSE to verify the alignment of far UV optics and the stable platform. Servicing: Film storage is provided by a common-use item.
Radio Astronomy	Checkout: GSE for monitoring operational parameter tests of power supply and output of integrator comparator. GSE signal generator to simulate output of Vee Antenna. Servicing: Magnetic tape storage is provided by common-use item.
Small Maneuverable Satellite	Checkout: GSE for monitoring operational parameter tests of command and data links between Phase I Lab and SMS, between Lab radar and SMS transponder, and the operation of the Lab SMS Flight Control System. GSE mass and form SMS simulator to test the Lab launching and docking mechanism. GSE signal generators to simulate the data output of SMS transmissions.

Figure 6.2-2. Flight 509 Summary of Functional Set Classes
(Sheet 2 of 5)

FLIGHT 509 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Experiment	Functional Set Class
Small Maneuverable Satellite (cont)	Handling: GSE to verify alignment of Lab launching and docking mechanism with SMS. GSE for SMS simulator. Servicing: Film storage and magnetic tape storage are provided by common-use items.
Magnetometer	Checkout, Handling, and Servicing: Same as Flights 507/511.
Propellant Handling Techniques (Water Transfer)	Checkout: GSE for monitoring operational parameter tests of pressure differential temperatures, and flow rate. GSE leak detection equipment for leak tests. Servicing: GSE to supply water and helium to the experiment equipment.
Extendable Rod Performance Test (Test No. 4 - STEM Rod)	Checkout: GSE for monitoring operational parameter tests of extension STEM motor. Servicing: Film storage and magnetic tape storage are provided by common-use items.
Compatibility Equipment	**Functional Set Class**
CSM Counter-Rotation Mechanism	Checkout: GSE for monitoring operational parameter tests of power supply, angular displacements, and angular rates in azimuth and elevation. GSE signal generator to provide displacement and rate signals. BMTE for development and operational tests of sub-assemblies, assemblies, and complete CSM counter-rotation mechanism. Handling: GSE to install and align equipment to spacecraft axes.

Figure 6.2-2. Flight 509 Summary of Functional Set Classes
(Sheet 3 of 5)

FLIGHT 509 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Compatibility Equipment	Functional Set Class
Video Monitor	Checkout: GSE for monitoring operational parameter tests of power supply and video output. GSE signal generator to provide input stimuli to video monitor unit. BMTE for development and operational tests of sub-assemblies and assemblies of video monitor. Handling: GSE for installation.
Time Lapse Camera (Near Field; +Z axis)	Checkout: GSE for monitoring operational parameter tests of camera. GSE target to provide input stimuli for camera. Handling: GSE to align camera to spacecraft +Z axis. Servicing: Film storage is provided by a common-use item.
Time Lapse Camera (Far Field; +Z axis) Time Lapse Camera (-Z axis)	Checkout, Handling, and Servicing: Same as Time Lapse Camera (Near Field; +Z axis).
Photographic Timing Reference	Checkout: Same as Flights 507/511.
Rendezvous Radar	Checkout and Handling: Same as LEM-Apollo Program.
Communications	Checkout and Handling: Same as LEM-Apollo Program.
Heat Transport Section	Checkout, Handling, and Servicing: Same as Flights 507/511.
Electrical Power	Checkout, Handling, Servicing: Same as Flights 507/511.

Figure 6.2-2. Flight 509 Summary of Functional Set Classes
(Sheet 4 of 5)

FLIGHT 509 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Compatibility Equipment	Functional Set Class
Signal Conditioner	Checkout: SITE (common-use item) and adapter to perform operational tests.
Controls and Displays	Checkout: SITE (common-use item) and adapter to perform operational tests.

Figure 6.2-2. Flight 509 Summary of Functional Set Classes
(Sheet 5 of 5)

FLIGHT 214 SUMMARY OF FUNCTIONAL SET CLASSES

Experiment	Functional Set Class
Radiation Monitoring	Checkout, Handling and Servicing: Same as Flights 507/511.
Magnetometer	Checkout, Handling, and Servicing: Same as Flights 507/511.
Control Moment Gyro	Checkout: GSE for monitoring operational parameter tests of power supply, gimbal angles and angular rates, and computer outputs. GSE special stimuli generator to provide input signals. Handling: GSE to verify alignment of gimbal axes to spacecraft axes. Servicing: Magnetic tape storage is provided by common-use item.
Optical Guidance System for Rendezvous	Checkout: GSE for monitoring operational parameter tests of power supply, range and range rate, angle and angular rate of the laser. GSE laser test generator, and stimuli signal generator. GSE optical target stimuli, same as Flight 509. Servicing: Magnetic tape storage is provided by common-use item.
RF Reflective Structure Deployment	Checkout: GSE for monitoring tests of pyrotechnic deployment circuit, gas pressure, and tether release mechanism. Servicing: GSE for supplying pressurized dry inert gas. Film storage is provided by common-use item.
On-board Guidance and Navigation Systems	Checkout: GSE for monitoring operational parameter tests of power supply, doppler altimeter, horizon scanner, sun sensor, radar, star tracker, and precision clock.

Figure 6.2-3. Flight 214 Summary of Functional Set Classes (Sheet 1 of 3)

FLIGHT 214 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Experiment	Functional Set Class
On-board Guidance and Navigation Systems (cont.)	Special stimuli generators for above equipment. (Some of the above equipment requirements may be satisfied by common-use items.) Handling: GSE to verify alignment of sensors to axes of spacecraft. (Some alignment equipment may be provided by common-use items.) Servicing: Magnetic tape storage is provided by common-use item.
Orbital Maneuvering and Docking	Checkout: GSE for monitoring operational parameter tests of power supply, long range radar, ruby laser, net capture device, and magnetic capture device. GSE stimuli generators for test signal inputs to radar and laser. SMS and long range radar support equipments same as Flight 509 and LEM-Apollo support equipments. Handling: GSE to verify alignment of radar antennas and laser interferometer. SMS and long range radar support equipments same as Flight 509 and LEM-Apollo Program. Servicing: Film and magnetic tape storage are provided by common-use items.
Propellant Handling Techniques Phases II and III	Checkout Functional Set Class GSE monitoring equipment for operational parameter tests of propellant transfer temperature, pressure differentials, leakage, relief valve operations, and regular flow. Servicing Functional Set Class GSE servicing equipment for supply of test fluids, flush and purge equipment, and supply of hydrogen peroxide and liquid oxygen.

Figure 6.2-3 Flight 214 Summary of Functional Set Classes (Sheet 2 of 3)

FLIGHT 214 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

Compatibility Equipment	Functional Set Class
Photographic Timing Reference	Checkout: Same as Flights 507/511.
Movie Camera	Checkout, Handling, and Servicing: Same as Flight 509.
Video Monitoring	Checkout: Same as Flight 509.
Rendezvous Radar	Checkout and Handling: Same as LEM-Apollo Program.
Communications	Checkout and Handling: Same as LEM-Apollo Program.
Guidance and Navigation Section	Checkout, Handling, and Servicing: Same as LEM-Apollo Program.
Signal Conditioner	Checkout: SITE (a common-use item) and SITE adapter to monitor operation of signal conditioner.
Tracking Light	Checkout: GSE to monitor test power supply and intensity of light. Handling: GSE for installation and alignment of light.
RCS Tanks	Checkout, Handling, and Servicing: Same as LEM-Apollo Program.
Orbital Storage	Checkout and Handling: Same as LEM-Apollo Program.
Mission Extension	Checkout, Handling, and Servicing: Same as LEM-Apollo Program.
Heat Transport Section	Checkout, Handling, and Servicing: Same as Flights 507/511.
Electrical Power	Checkout, Handling, and Servicing: Same as Flights 507/511.
Controls & Displays	Checkout: SITE (a common-use item) and SITE adapter to perform operational tests of controls and displays.

Figure 6.2-3 Flight 214 Summary of Functional Set Classes (Sheet 3 of 3)

FLIGHT 216 SUMMARY OF FUNCTIONAL SET CLASSES

Experiment	Functional Set Class
Radiation Monitoring	Checkout, Handling, and Servicing: Same as Flights 507/511.
Magnetometer	Checkout, Handling, and Servicing: Same as Flights 507/511.
Capillarity Studies	Checkout: GSE for monitoring operational parameter tests of power supply, electronic flow meter, and timers. GSE signal stimuli for input signals to flow meter and timers. Handling: GSE to verify alignment of cameras and microscope. Servicing: GSE to supply test fluids. Film storage is provided by a common-use item.
Spacesuit Evaluation	Checkout, Handling, and Servicing: Same as LEM-Apollo Program.
Manned Locomotion and Maneuvering Capability	This EVA experiment requires no Checkout, Handling, or Servicing support.
Emergency Techniques for Rescue	This EVA requires no Checkout, Handling, or Servicing support.
Development of Personnel and Cargo Transfer Operations	This EVA experiment requires no Checkout, Handling, or Servicing support.
Propellant Handling Techniques, Phase II AMU Propellant Transfer (H_2 O_2)	Checkout and Servicing: Same as Flight 214.
Expandable Airlock	Checkout: GSE for monitoring operational parameter tests of pressure, leakage temperatures, valves and pressure regulators, and deployment and retractor mechanisms.

Figure 6.2-4. Flight 216 Summary of Functional Set Classes (Sheet 1 of 3)

FLIGHT 216 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

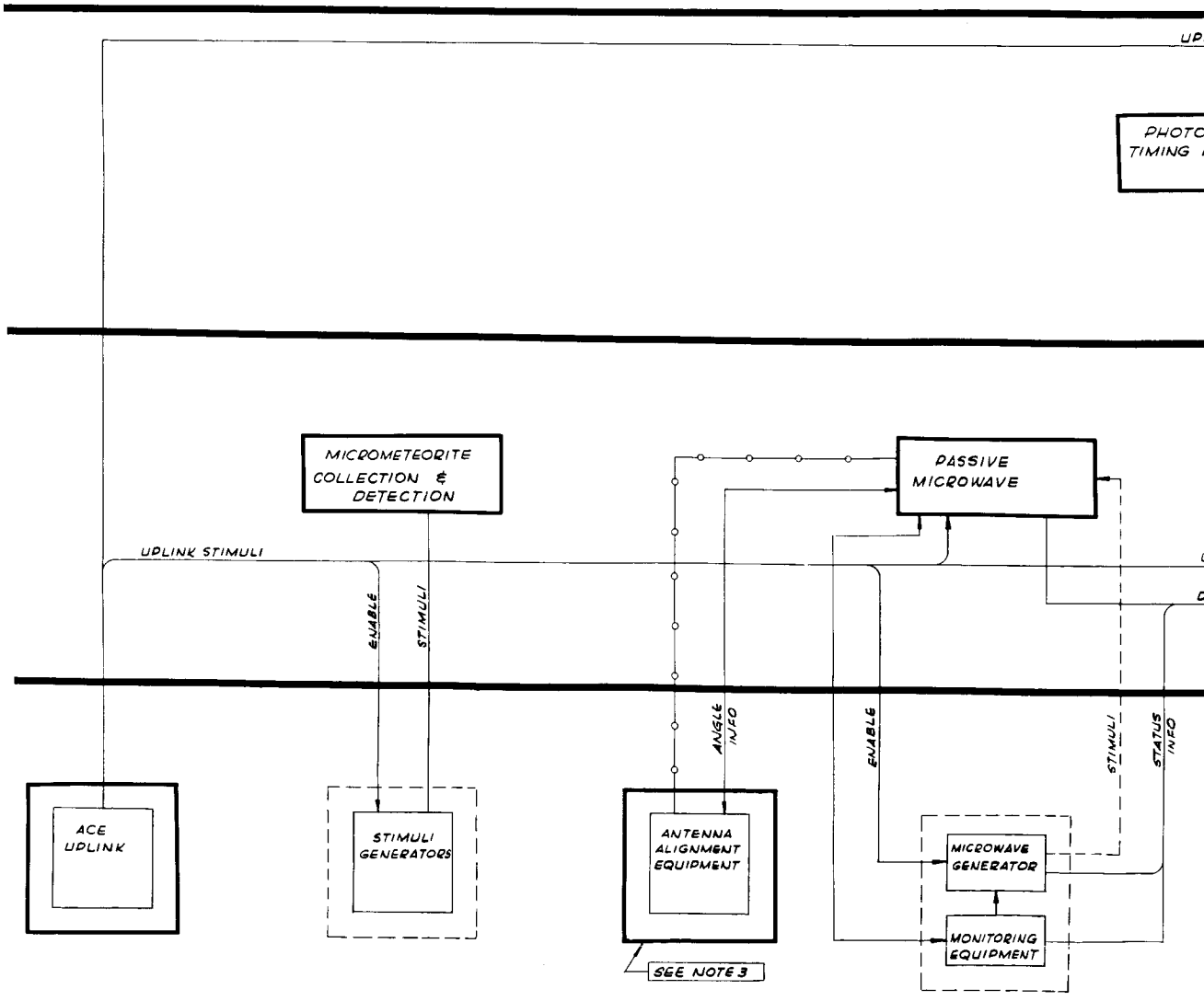
Experiment	Functional Set Class
Expandable Airlock (cont)	Handling: GSE altitude chamber workstand to conduct operational tests of the Expandable Airlock in the altitude chamber. Servicing: Film and magnetic tape storage are provided by common-use items.
Extendable Rod Performance Tests	Checkout: GSE for monitoring operational parameter tests of the deploying mechanism of the wire rod phases. (Additional GSE same as, Flight 509 for STEM phase of experiment). Servicing: Film and magnetic tape storage are provided by common-use items.
Compatibility Equipment	**Functional Set Class**
Tilt Table	Checkout: GSE to test the remote control operation of the tilt table. Handling: GSE to install and align the tilt table to spacecraft axes.
Frame Camera	Checkout, Handling, and Servicing: Same as Flight 509.
Video Monitoring	Checkout and Handling: Same as Flight 509.
Hard Airlock	Checkout: Same as for Expandable Airlock (experiment).
Photographic Timing Reference	Checkout: Same as Flights 507/511.
Time Lapse Camera (Near Field; +Z axis) Time Lapse Camera (Far Field; +Z axis)	Checkout, Handling, and Servicing: Flight 509.
Signal Conditioner	Checkout: SITE (a common-use item) and adapter for SITE tie test the signal conditioner.

Figure 6.2-4 Flight 216 Summary of Functional Set Classes (Sheet 2 of 3)

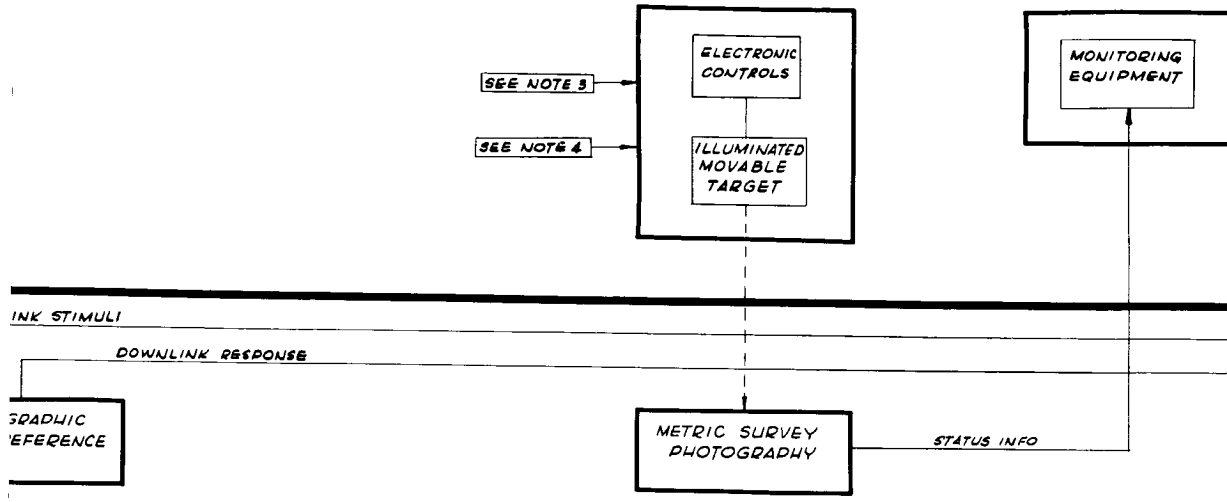
FLIGHT 216 SUMMARY OF FUNCTIONAL SET CLASSES (cont.)

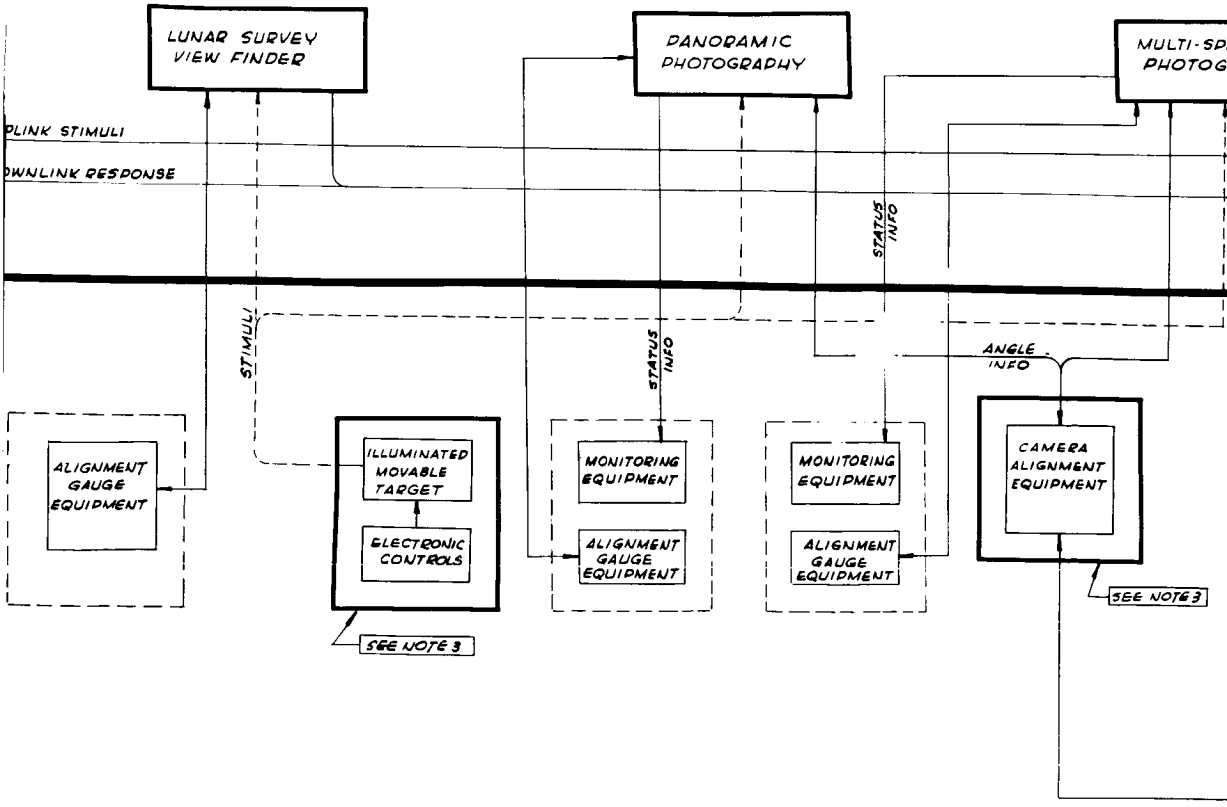
Compatibility Equipment	Functional Set Class
Tracking Light	Checkout and Handling: Same as Flight 214.
Orbital Storage	Checkout: Same as Flight 214.
Mission Extension	Checkout, Handling, and Servicing: Same as Flight 214.
Electrical Power	Checkout, Handling, and Servicing: Same as Flights 507/511.
Controls & Displays	Checkout: SITE (a common-use item) and adapter to perform operational tests of the Controls and Displays.
EVA Support Equipment	Checkout: GSE for monitoring operational parameter tests of MMU receiver and tether line motor. GSE signal generator to provide input stimuli for MMU receiver. GSE to measure pressure, temperature, flow rates, valve operations, and leak detection of MMU fuel supply system. Handling: GSE for installation and alignment of MMU antenna and receiver, and fuel supply system. Servicing: GSE to provide test fluids and service fluids to the MMU fuel supply system.

Figure 6.2-4 Flight 216 Summary of Functional Set Classes (Sheet 3 of 3)

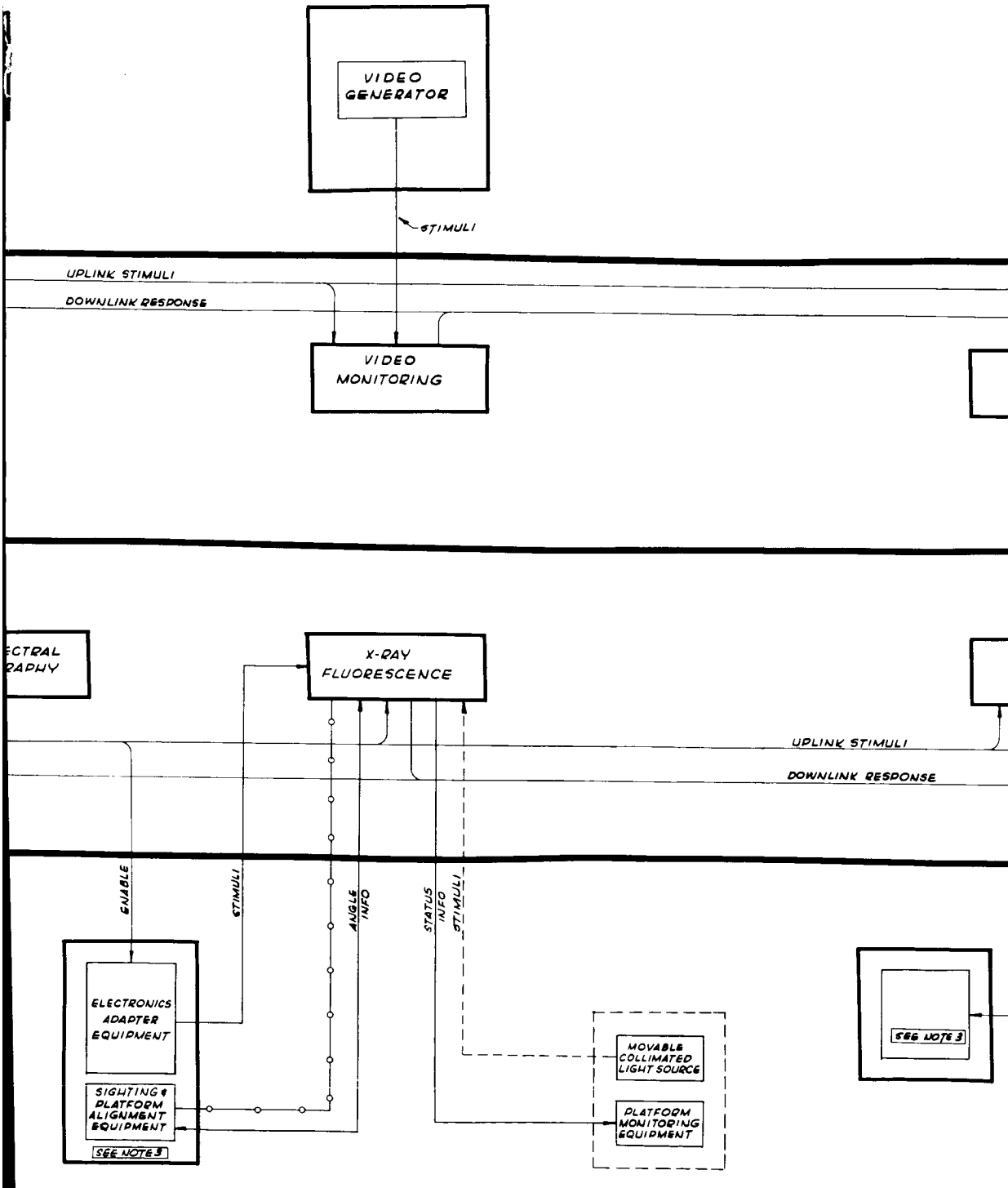

UP
PHOTO
TIMING
MICROMETEORITE
COLLECTION &
DETECTION
PASSIVE
MICROWAVE
UPLINK STIMULI
ENABLE
STIMULI
ANGLE
INFO
ENABLE
STIMULI
STATUS
INFO
ACE
UPLINK
STIMULI
GENERATORS
ANTENNA
ALIGNMENT
EQUIPMENT
MICROWAVE
GENERATOR
MONITORING
EQUIPMENT
SEE NOTE 3

6.4.1-A-1

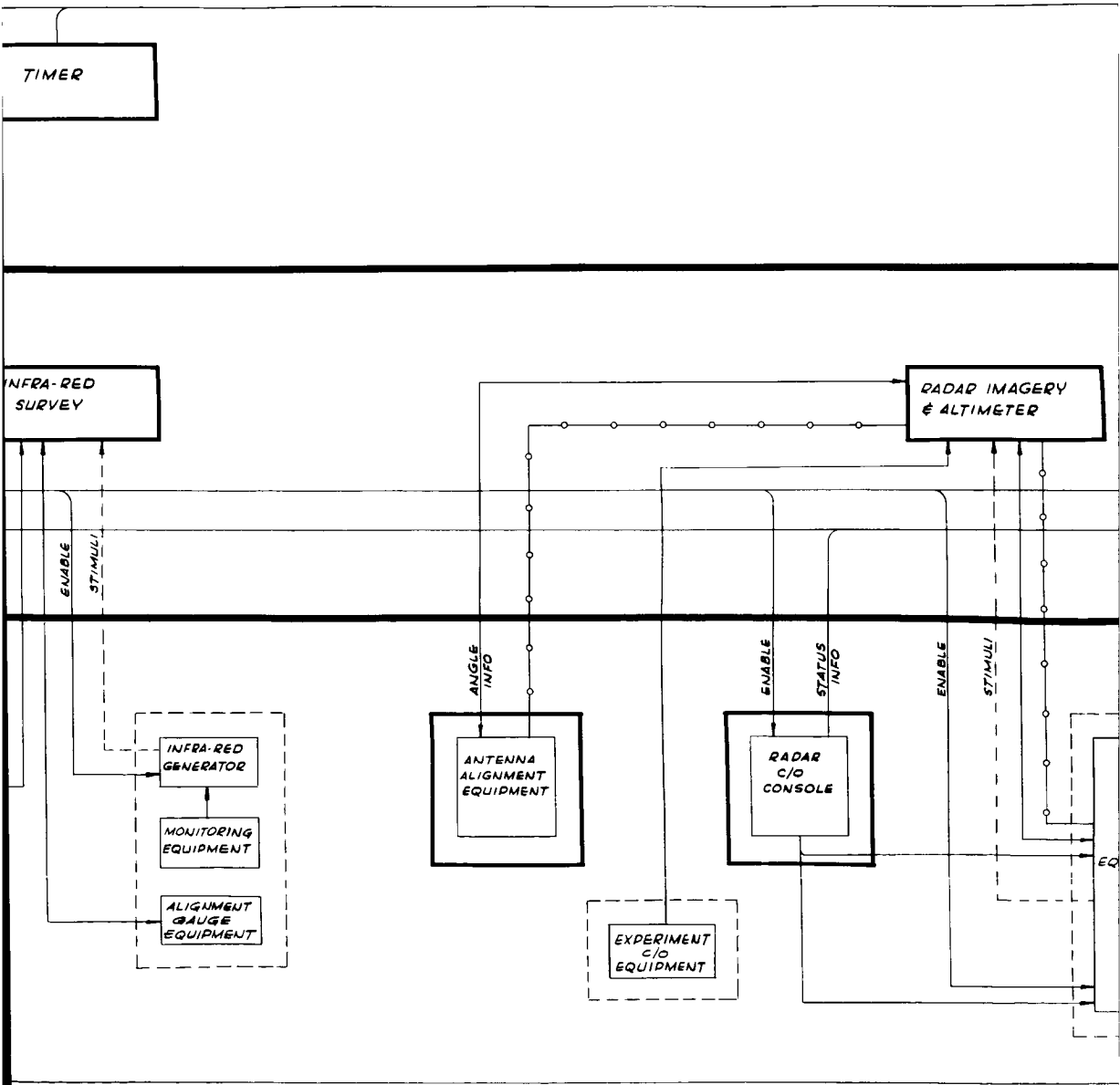

SEE NOTE 3
SEE NOTE 4
ELECTRONIC CONTROLS
ILLUMINATED MOVABLE TARGET
MONITORING EQUIPMENT
INK STIMULI
DOWNLINK RESPONSE
GRAPHIC REFERENCE
METRIC SURVEY PHOTOGRAPHY
STATUS INFO


LUNAR SURVEY VIEW FINDER
PANORAMIC PHOTOGRAPHY
MULTI-SP PHOTOG
PLINK STIMULI
OWNLINK RESPONSE
STATUS INFO
STIMULI
STATUS INFO
ANGLE INFO
ALIGNMENT GAUGE EQUIPMENT
ILLUMINATED MOVABLE TARGET
ELECTRONIC CONTROLS
MONITORING EQUIPMENT
ALIGNMENT GAUGE EQUIPMENT
MONITORING EQUIPMENT
ALIGNMENT GAUGE EQUIPMENT
CAMERA ALIGNMENT EQUIPMENT
SEE NOTE 3
SEE NOTE 3

6.4-1B-2


VIDEO GENERATOR
STIMULI
UPLINK STIMULI
DOWNLINK RESPONSE
VIDEO MONITORING
X-RAY FLUORESCENCE
UPLINK STIMULI
DOWNLINK RESPONSE
ENABLE
STIMULI
ANGLE INFO
STATUS INFO
STIMULI
ELECTRONICS ADAPTER EQUIPMENT
SIGHTING & PLATFORM ALIGNMENT EQUIPMENT
SEE NOTE 3
MOVABLE COLLIMATED LIGHT SOURCE
PLATFORM MONITORING EQUIPMENT
SEE NOTE 3

6-4-1-A-3


TIMER
INFRA-RED SURVEY
RADAR IMAGERY & ALTIMETER
ENABLE
STIMULI
ANGLE INFO
ENABLE
STATUS INFO
ENABLE
STIMULI
INFRA-RED GENERATOR
MONITORING EQUIPMENT
ALIGNMENT GAUGE EQUIPMENT
ANTENNA ALIGNMENT EQUIPMENT
RADAR C/O CONSOLE
EXPERIMENT C/O EQUIPMENT

6.4-1-A-4

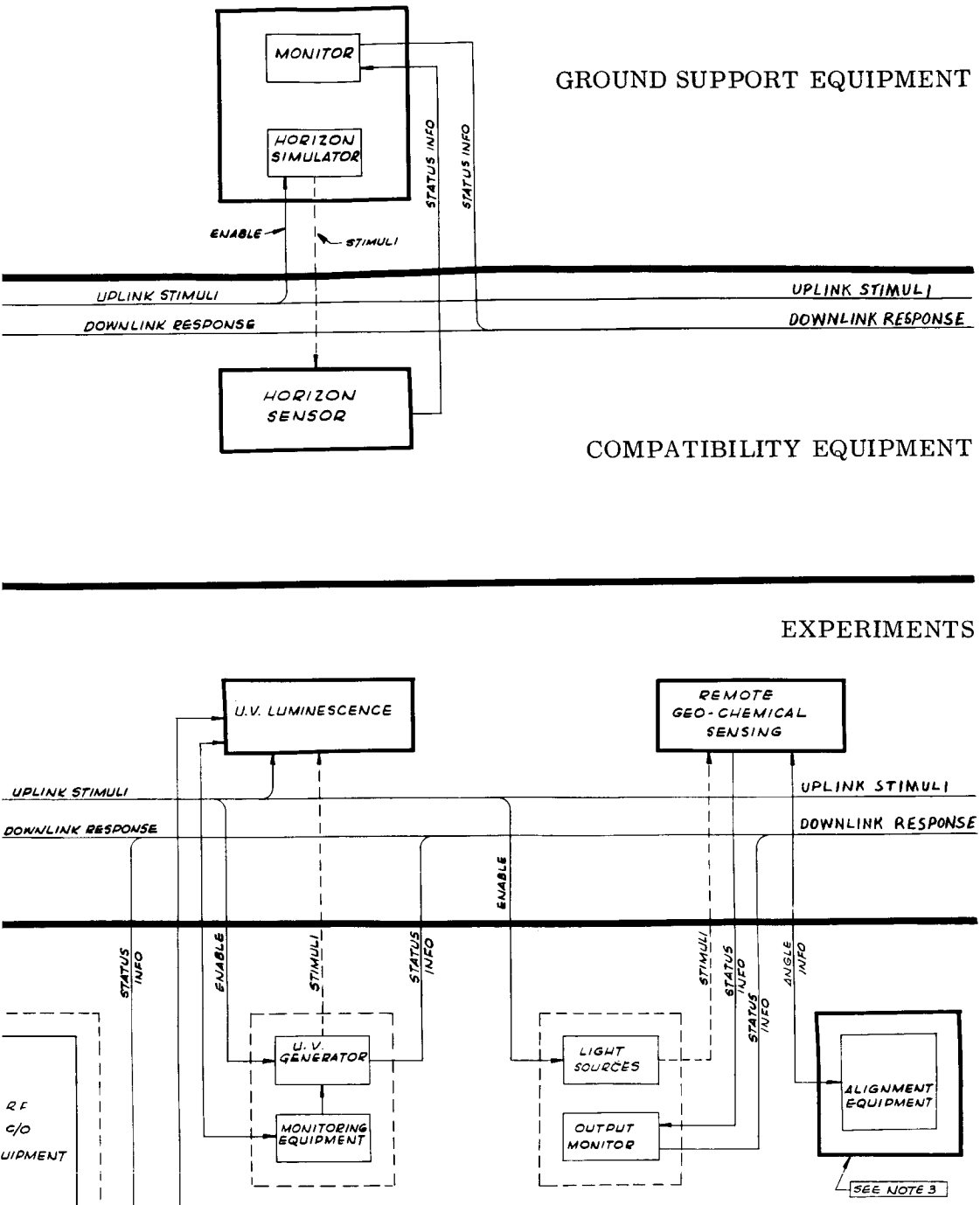
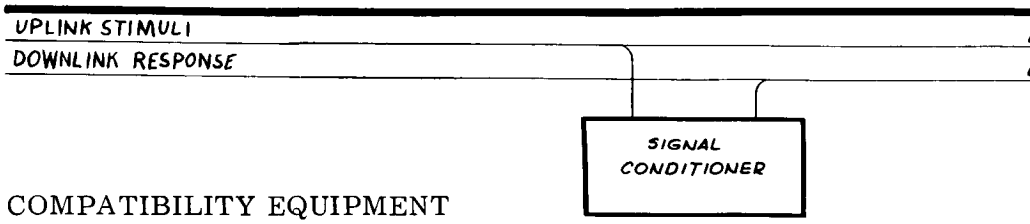


Figure 6.4-1 GSE Functional Configuration For Flights 507/511 (Sheet 1 of 2)

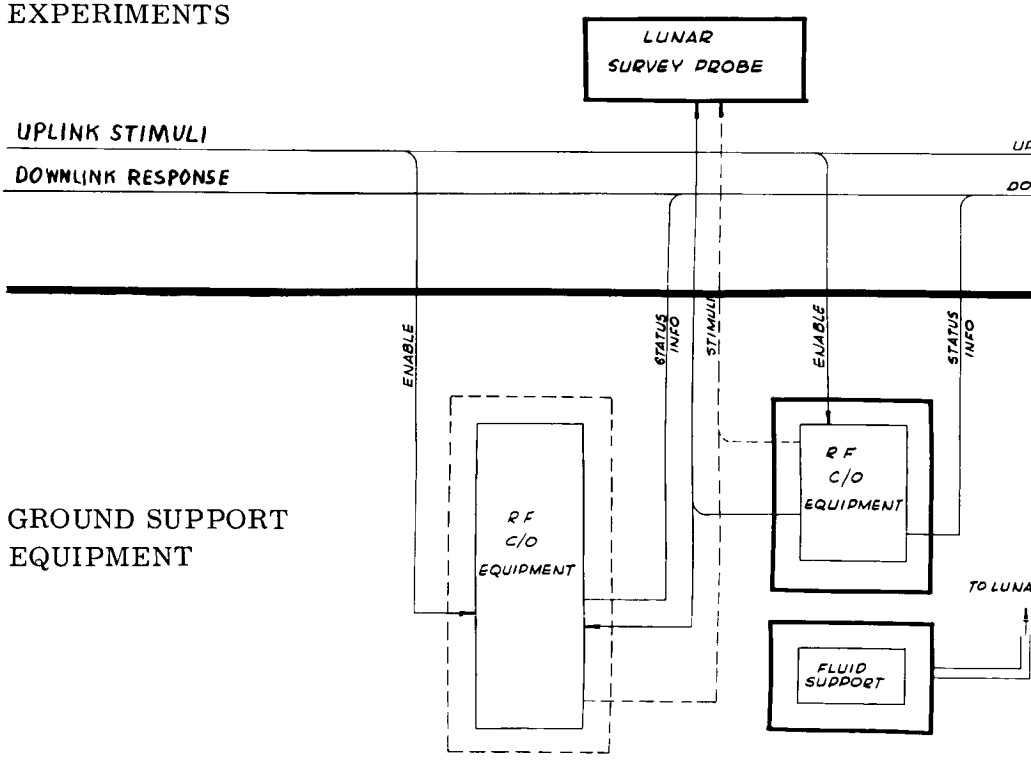
Grumman

GROUND SUPPORT EQUIPMENT



COMPATIBILITY EQUIPMENT

EXPERIMENTS

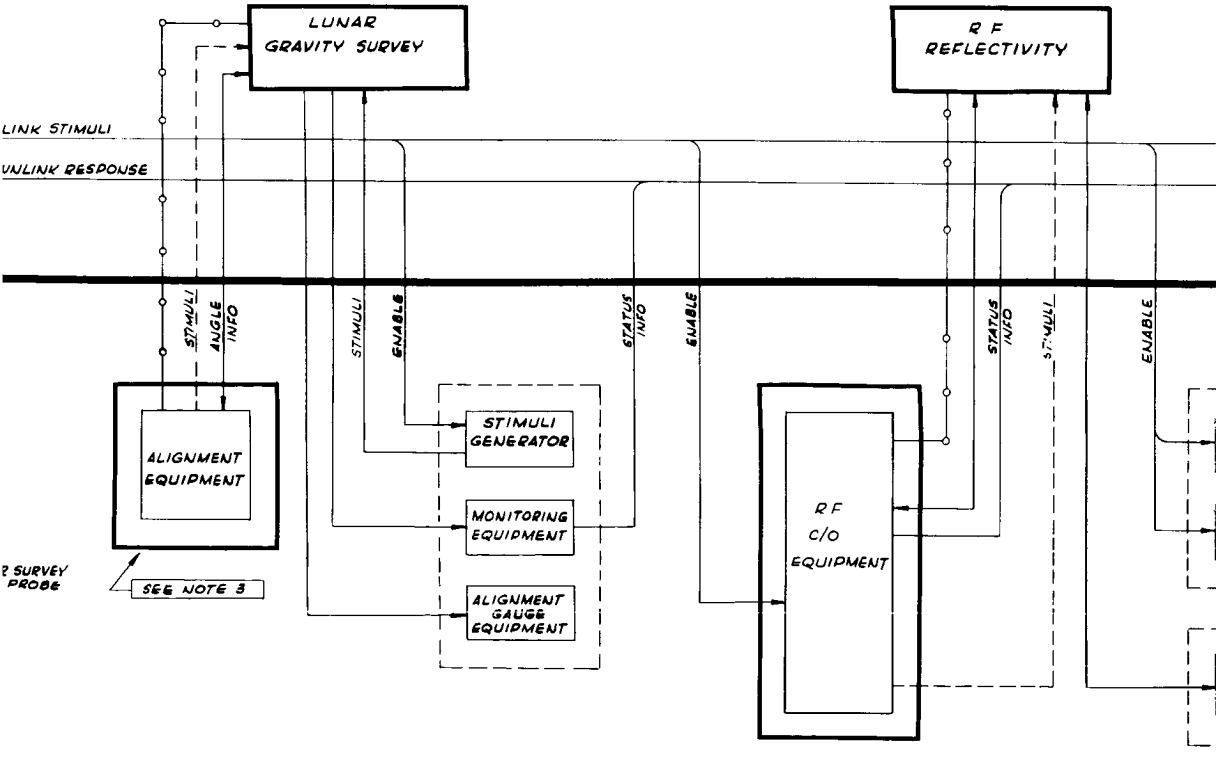


GROUND SUPPORT EQUIPMENT

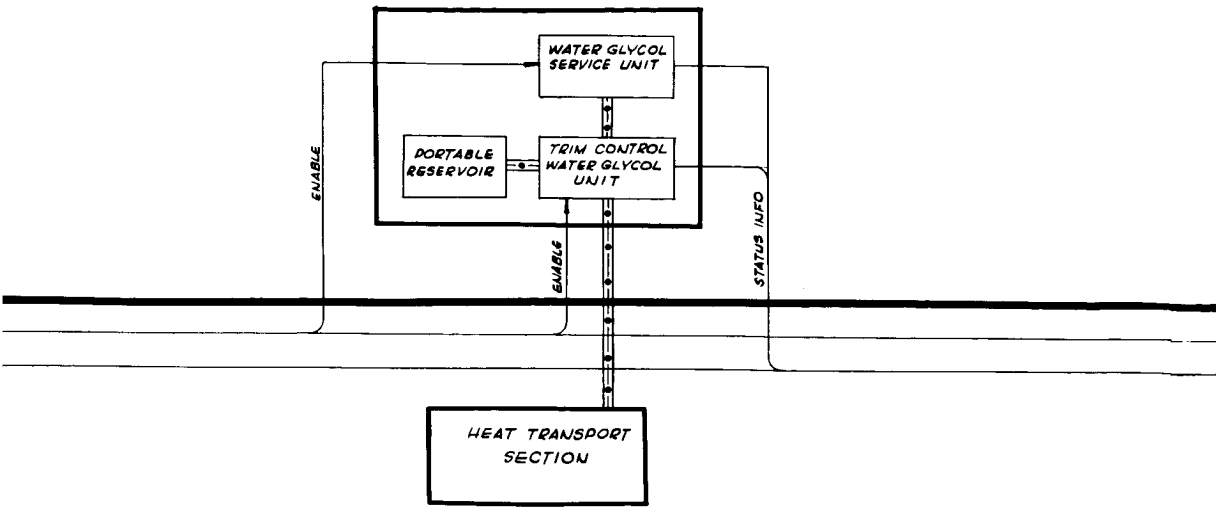
6.4-1B-1

PLINK STIMULI

OWNLINK RESPONSE



6.4-1.B-2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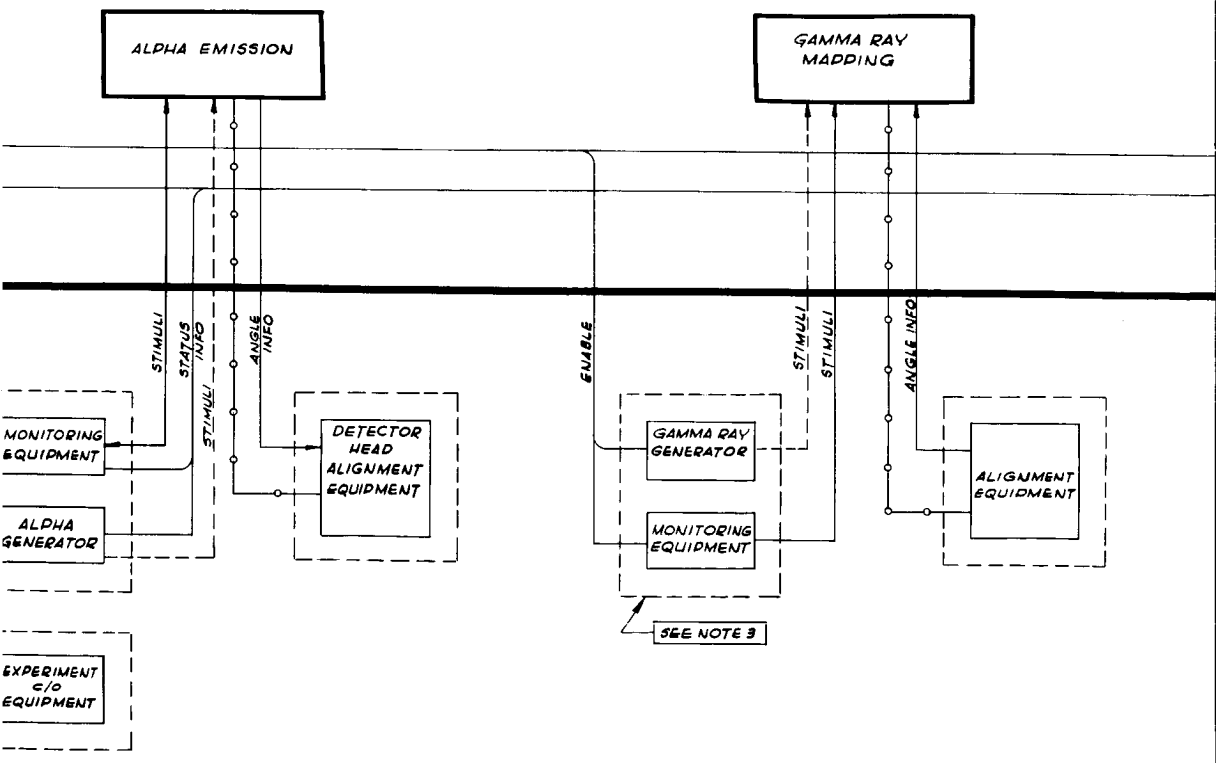
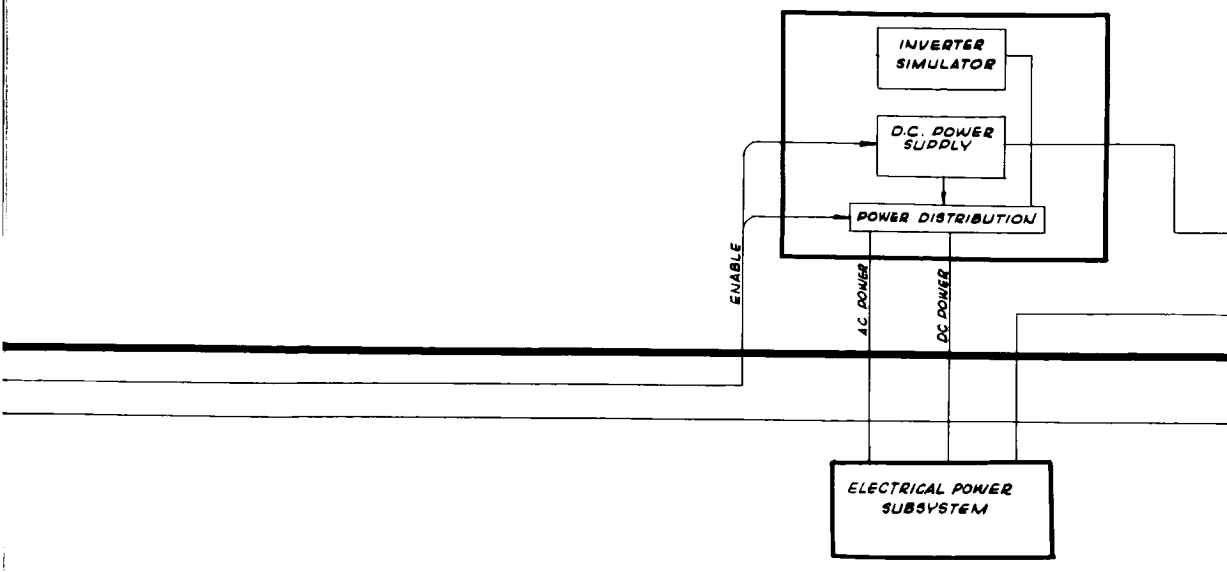
PORTABLE RESERVOIR
TRIM CONTROL WATER GLYCOL UNIT
ENABLE
ENABLE
STATUS INFO
HEAT TRANSPORT SECTION


ALPHA EMISSION
GAMMA RAY MAPPING
STIMULI
STATUS INFO
STIMULI
ANGLE INFO
ENABLE
STIMULI
STIMULI
ANGLE INFO
MONITORING EQUIPMENT
ALPHA GENERATOR
DETECTOR HEAD ALIGNMENT EQUIPMENT
GAMMA RAY GENERATOR
MONITORING EQUIPMENT
ALIGNMENT EQUIPMENT
SEE NOTE 3
EXPERIMENT C/O EQUIPMENT

64-1-B-3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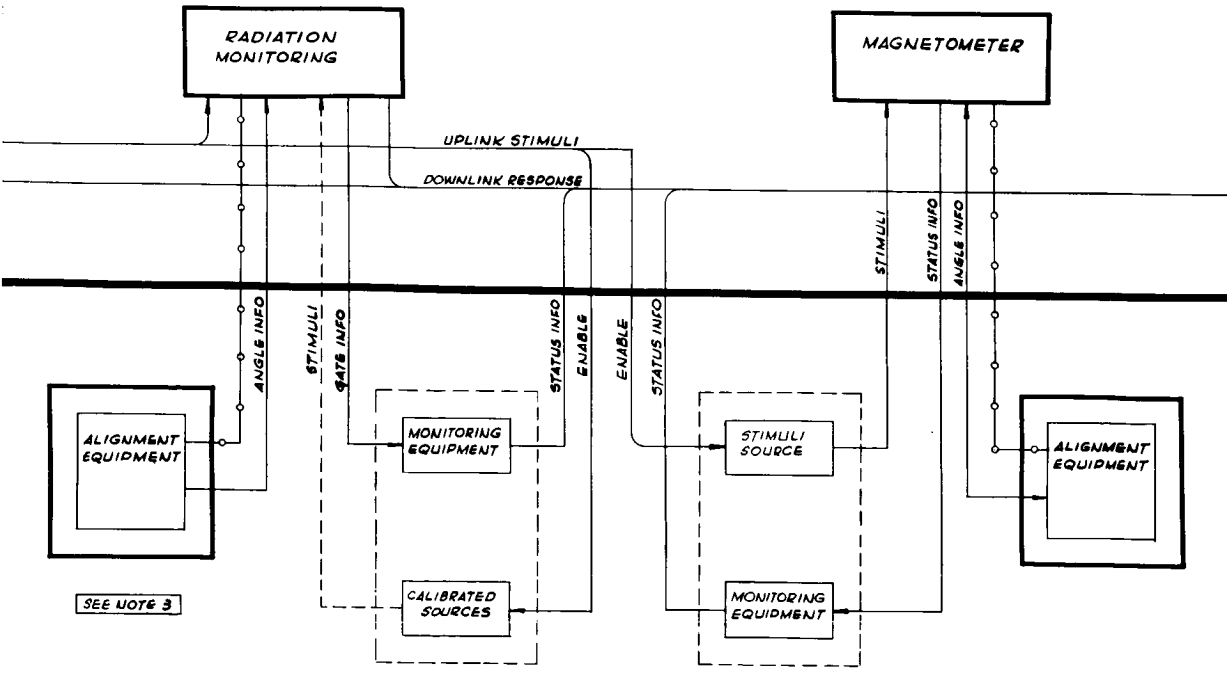
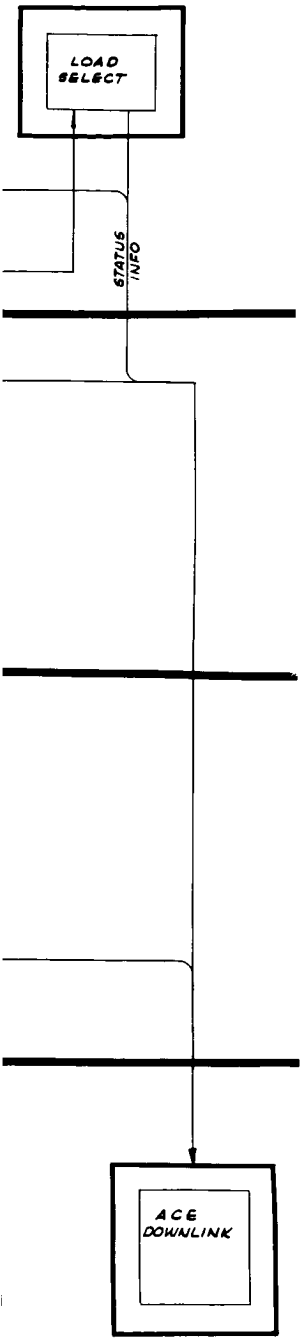
D.C. POWER SUPPLY
POWER DISTRIBUTION
ENABLE
AC POWER
DC POWER
ELECTRICAL POWER SUBSYSTEM


RADIATION MONITORING
MAGNETOMETER
UPLINK STIMULI
DOWNLINK RESPONSE
ANGLE INFO
STIMULI
GATE INFO
STATUS INFO
ENABLE
ENABLE
STATUS INFO
STIMULI
STATUS INFO
ANGLE INFO
ALIGNMENT EQUIPMENT
MONITORING EQUIPMENT
STIMULI SOURCE
ALIGNMENT EQUIPMENT
CALIBRATED SOURCES
MONITORING EQUIPMENT
SEE NOTE 3



Notes

1. This is a tentative functional integrated diagram of the ground support equipment required to check out the Flight 507/511 experiments and compatability packages.
2. No bench test maintenance equipment (BTME) is shown on the drawing.
3. The sighting equipment is the same for all the sections where the "See Note 3" is indicated on the drawing.
4. This equipment is for common usage among the following experiments: Panoramic Photography, Multi Spectral Photography, Lunar Survey Viewfinder, and the Ultra-Violet Luminescence.

Abbreviations

UV - Ultra-Violet
C/O - Checkout
Info - Information
ACE - Acceptance Checkout Equipment
Gov't - Government

Symbols

- Gov't Furnished Equipment
- Contractor Furnished Equipment
- Electromagnetic Link
- Mechanical Link
- Coolant
- Fluid Link

B 5

Figure 6.4-1 GSE Functional Configuration For Flights 507/511 (Sheet 2 of 2)

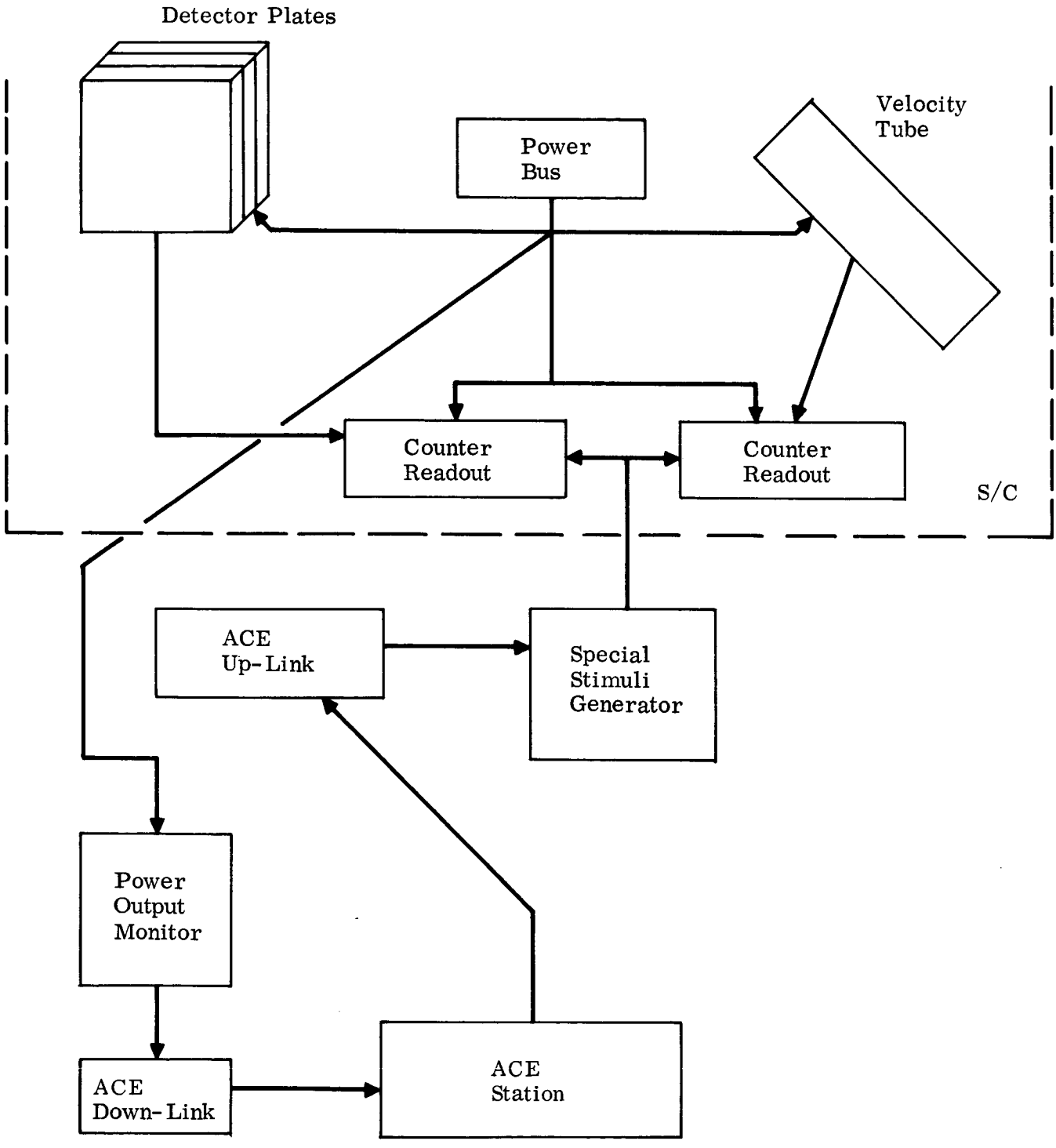


Figure 6.5-1 Micrometeorite Collection & Detection GSE Functional Block Diagram, Flights 507/511

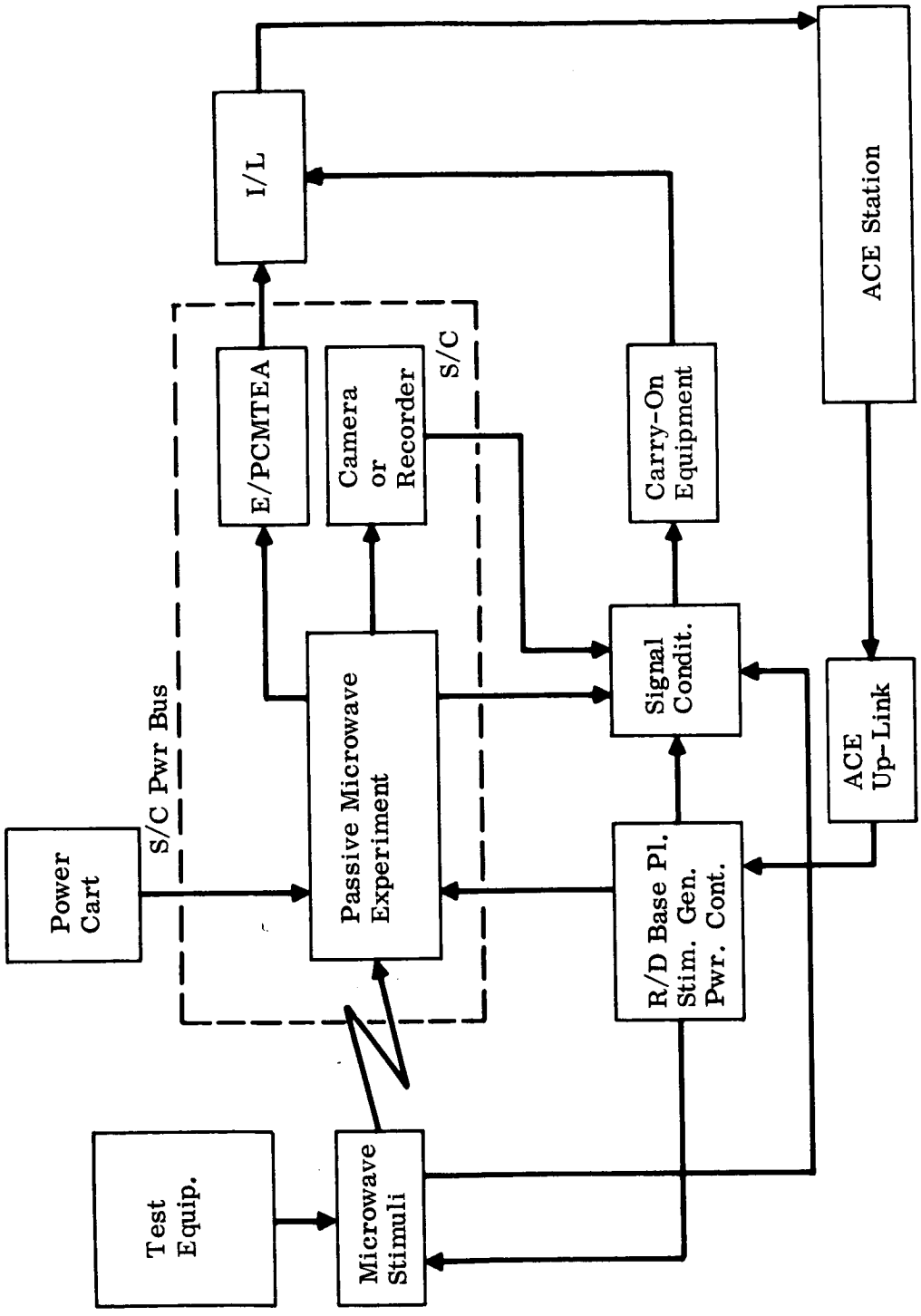


Figure 6.5-2 Passive Microwave GSE Functional Block Diagram, Flights 507/511

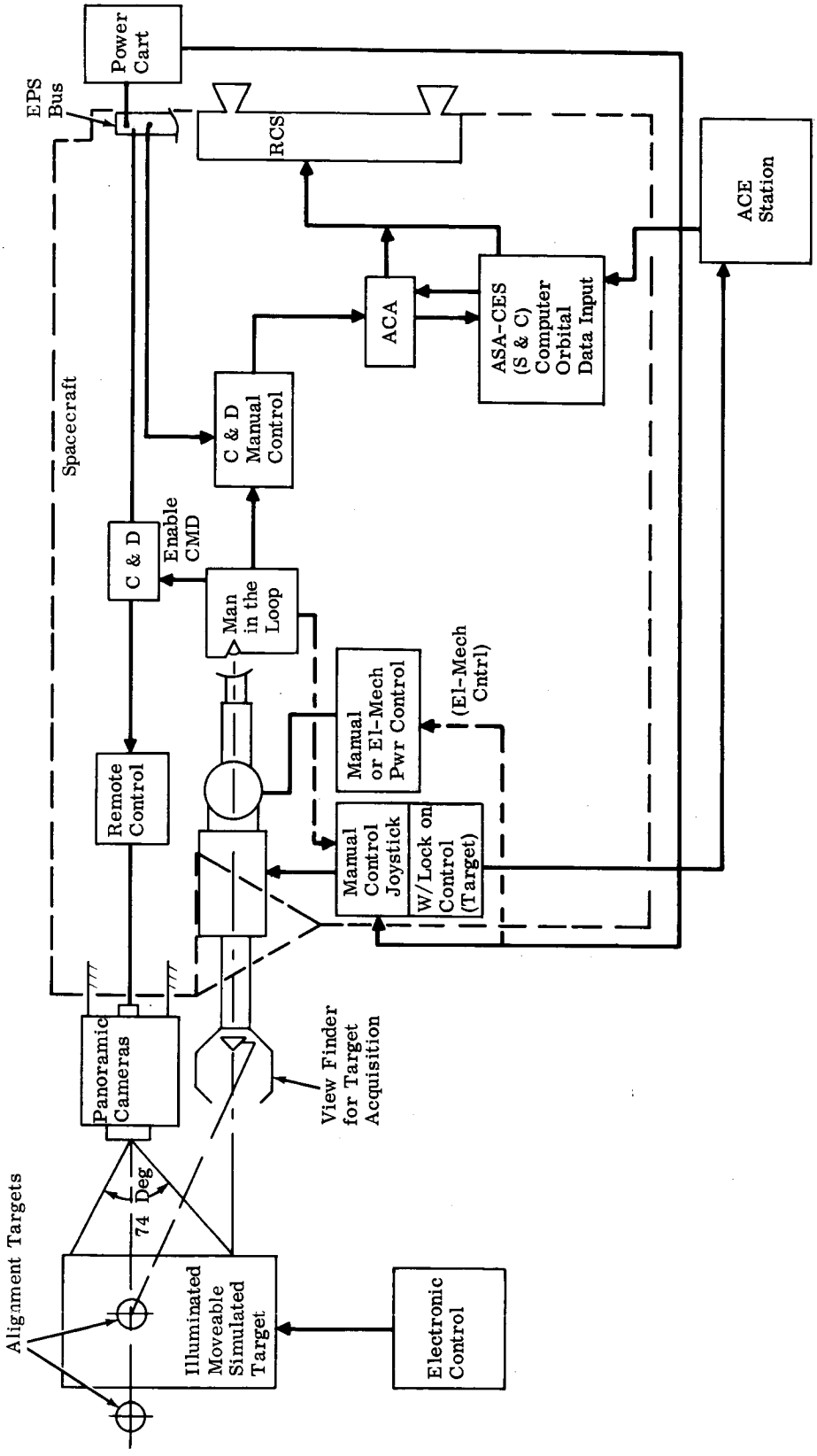


Figure 6.5-3 Panoramic Photography GSE Functional Block Diagram, Flights 507/511

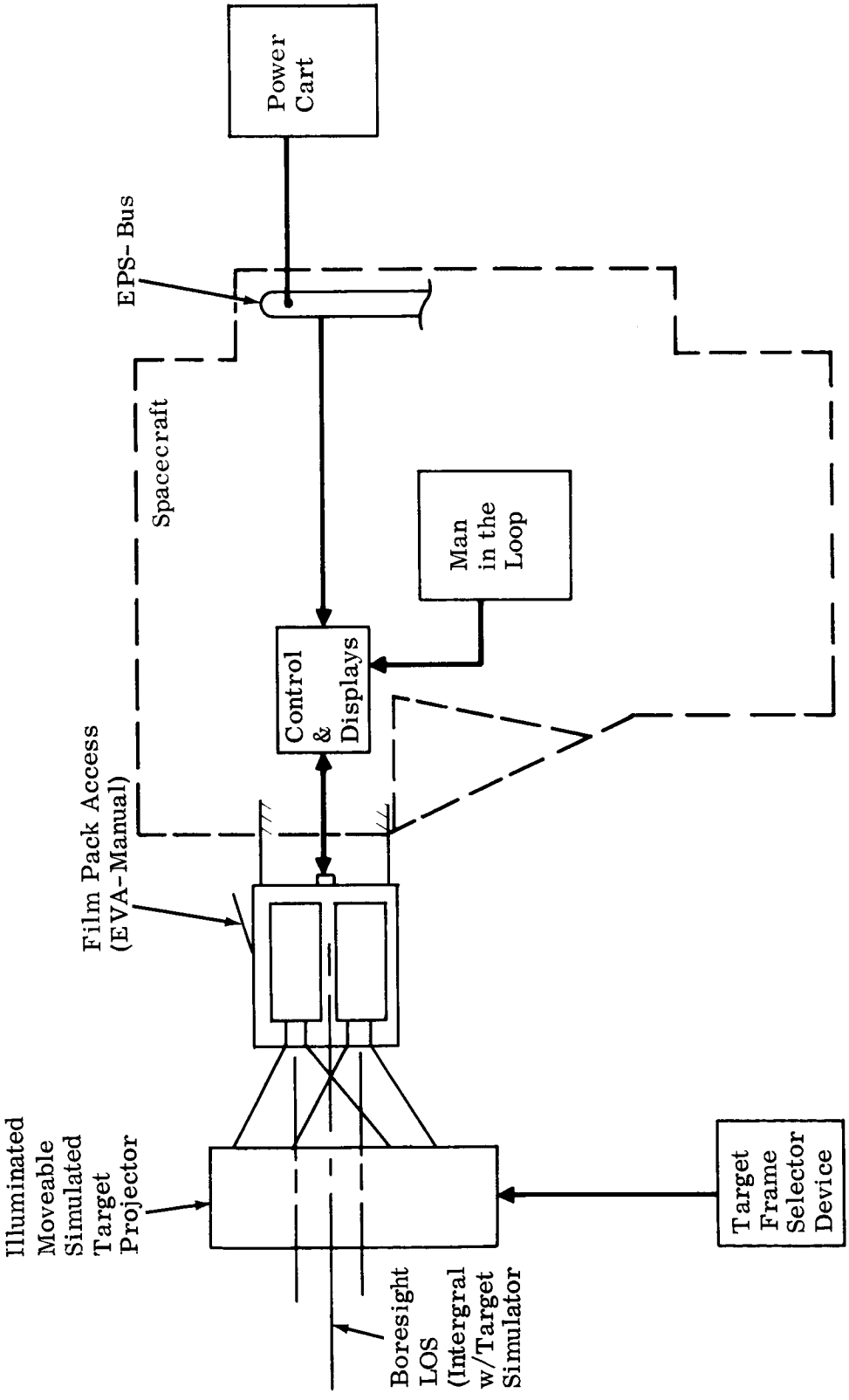


Figure 6.5-4 Multispectral Photography GSE Functional Block Diagram, Flights 507/511

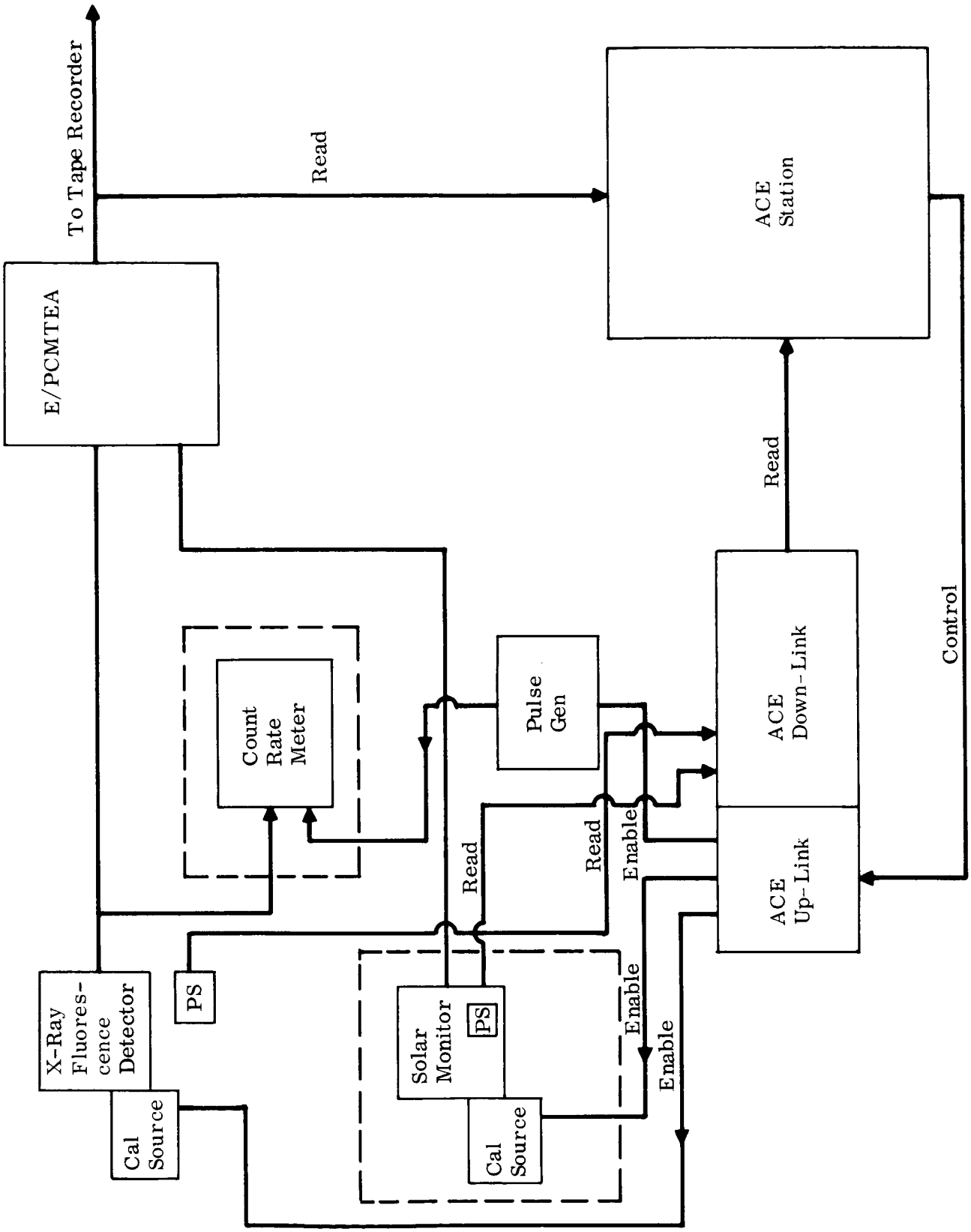


Figure 6.5-5 X-Ray Fluorescence GSE Functional Block Diagram, Flights 507/511

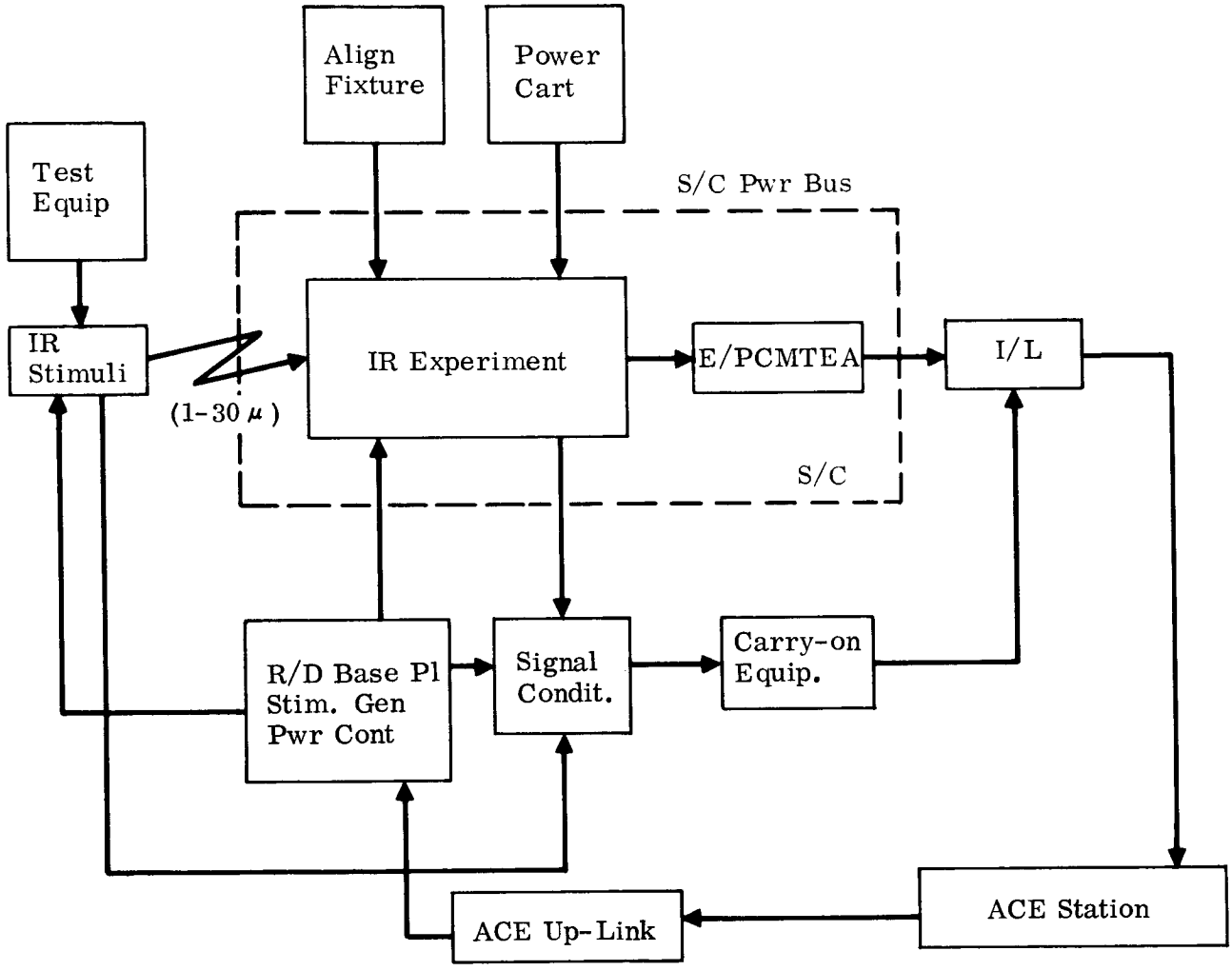


Figure 6.5-6 Infra-Red Survey GSE Functional Block Diagram, Flights 507/511

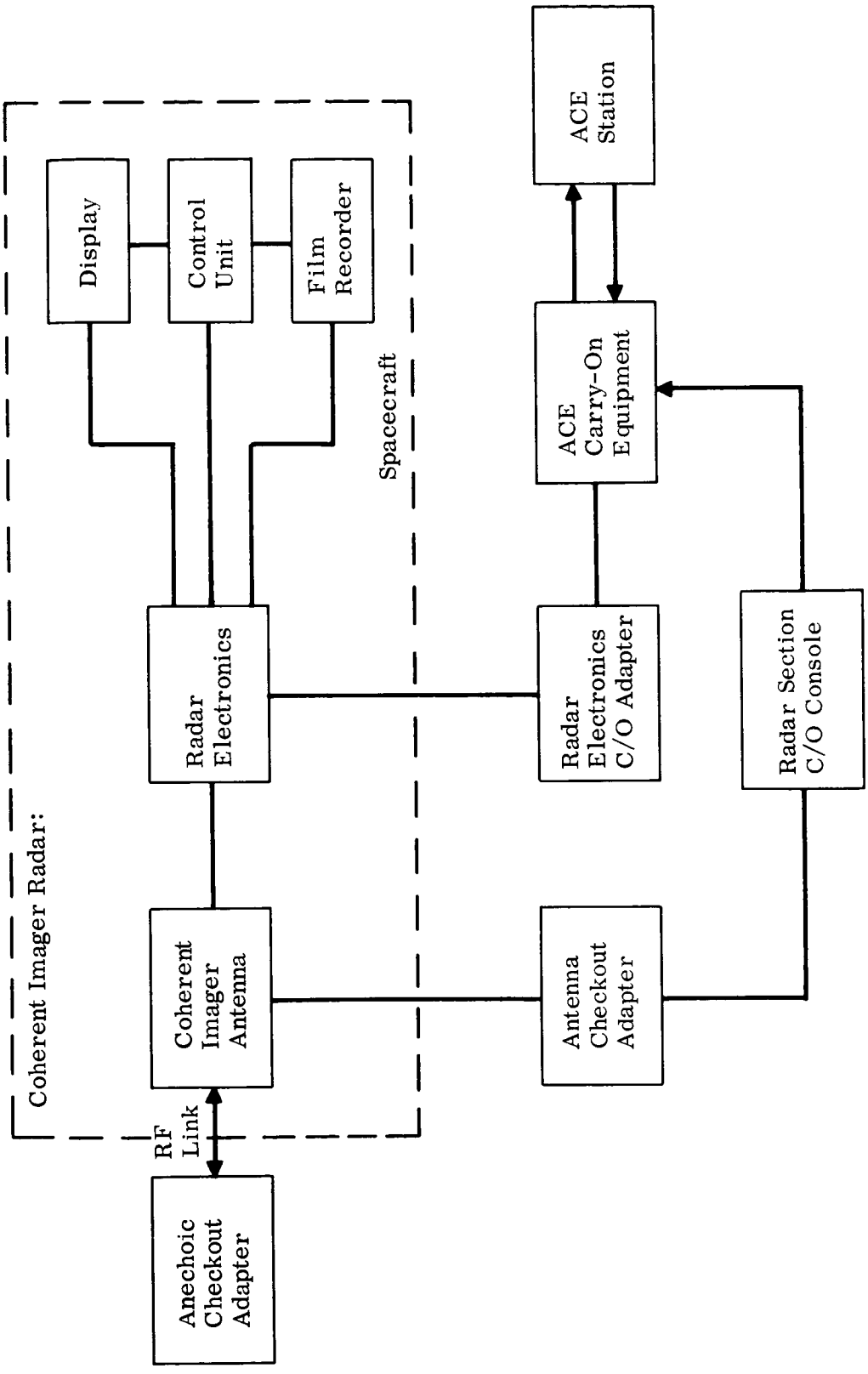


Figure 6.5-7 Radar Imagery, Alimeters, and Surface State GSE Functional Block Diagram, Flights 507/511 (Sheet 1 of 2)

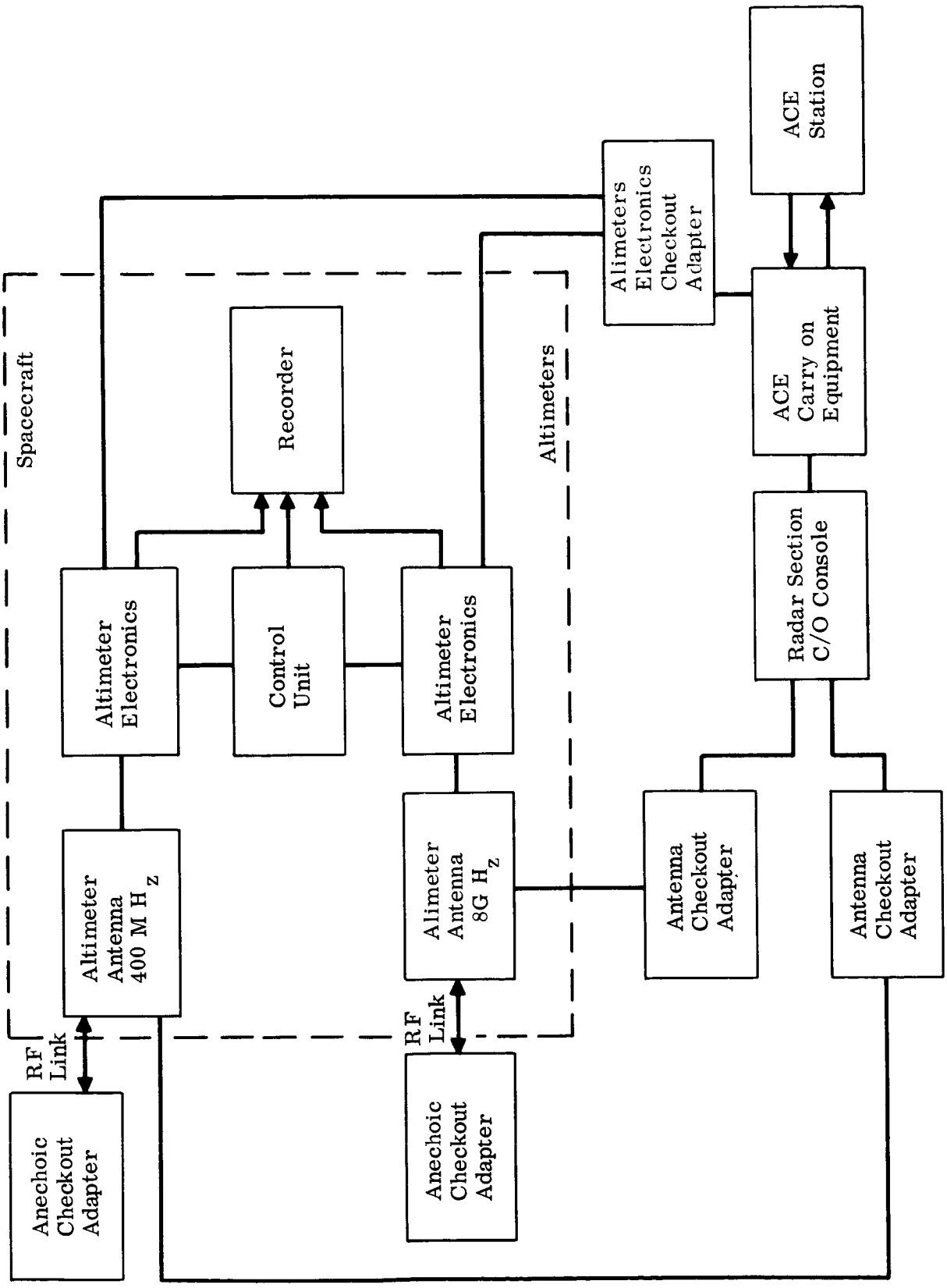


Figure 6.5-7 Radar Imagery, Alimeters, and Surface State GSE Functional Block Diagram, Flights 507/511 (Sheet 2 of 2)

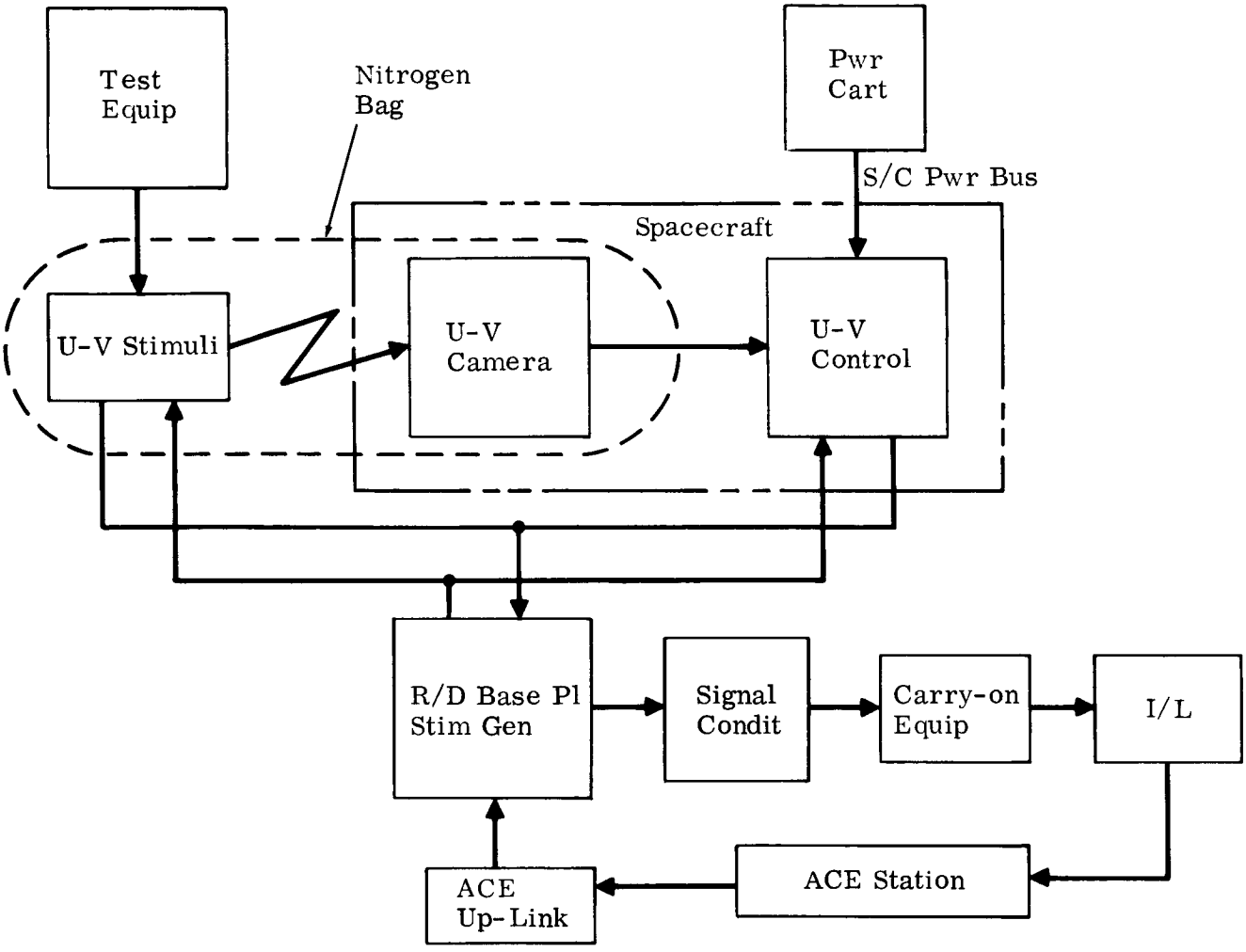


Figure 6.5-8 Ultra-Violet Luminescence GSE Functional Block Diagram, Flights 507/511

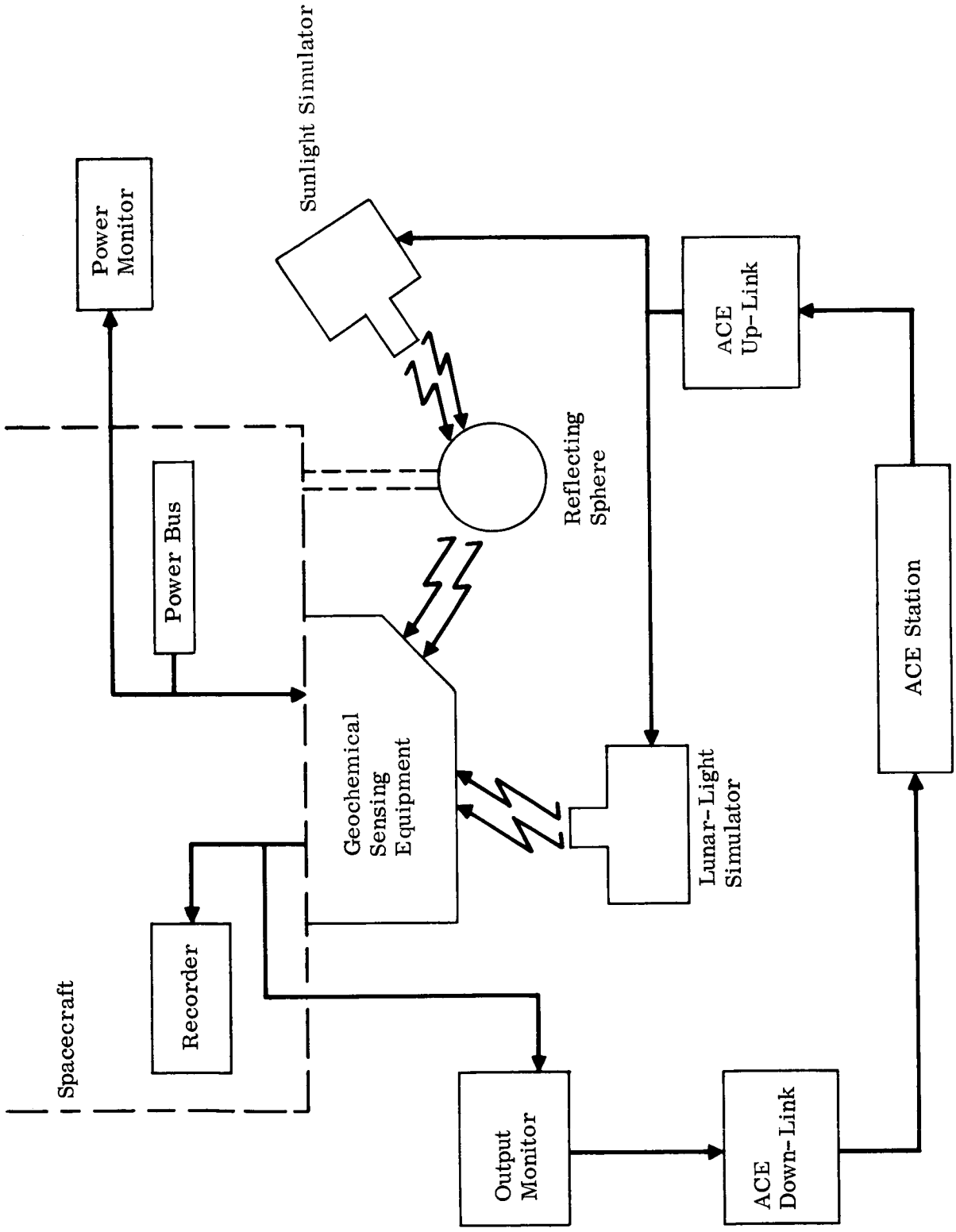


Figure 6.5-9 Remote Geochemical Sensing GSE Functional Block Diagram, Flights 507/511

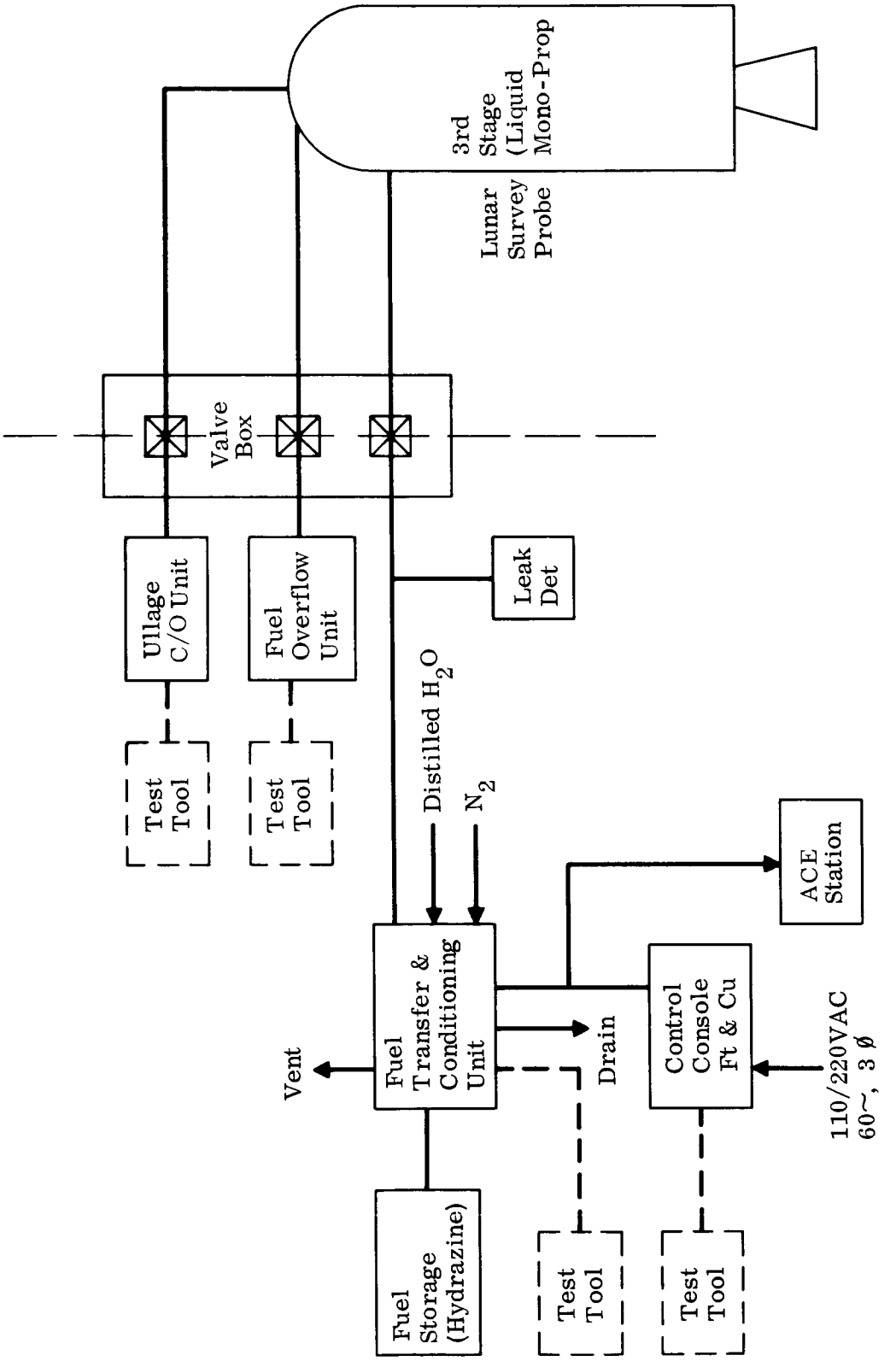


Figure 6.5-10 Lunar Surface Probe GSE Functional Block Diagram, Flights 507/511 (Sheet 1 of 2)

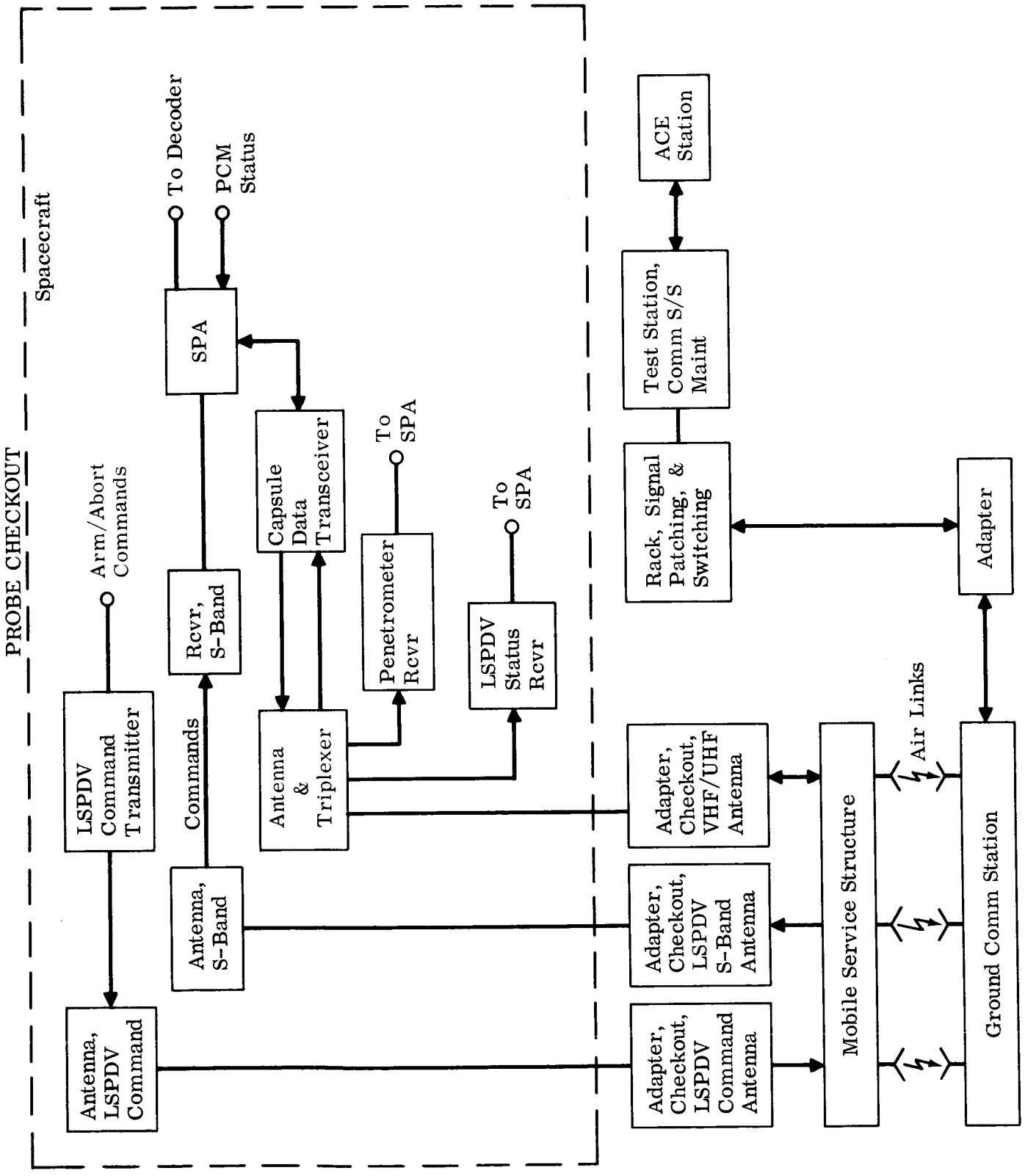


Figure 6.5-10 Lunar Surface Probe GSE Functional Block Diagram, Flights 507/511 (Sheet 2 of 2)

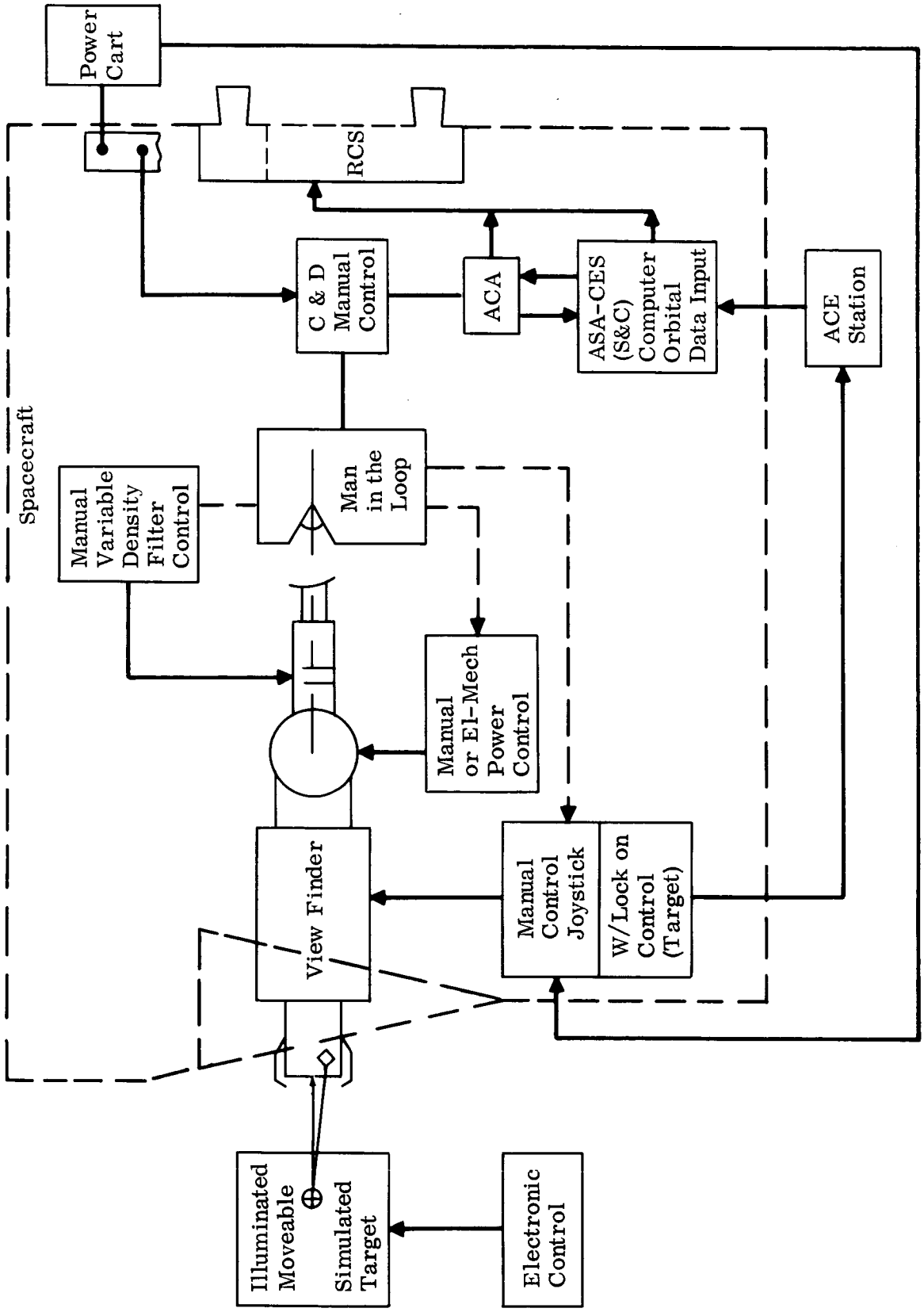


Figure 6.5-11 Lunar Survey Viewfinder GSE Functional Block Diagram, Flights 507/511

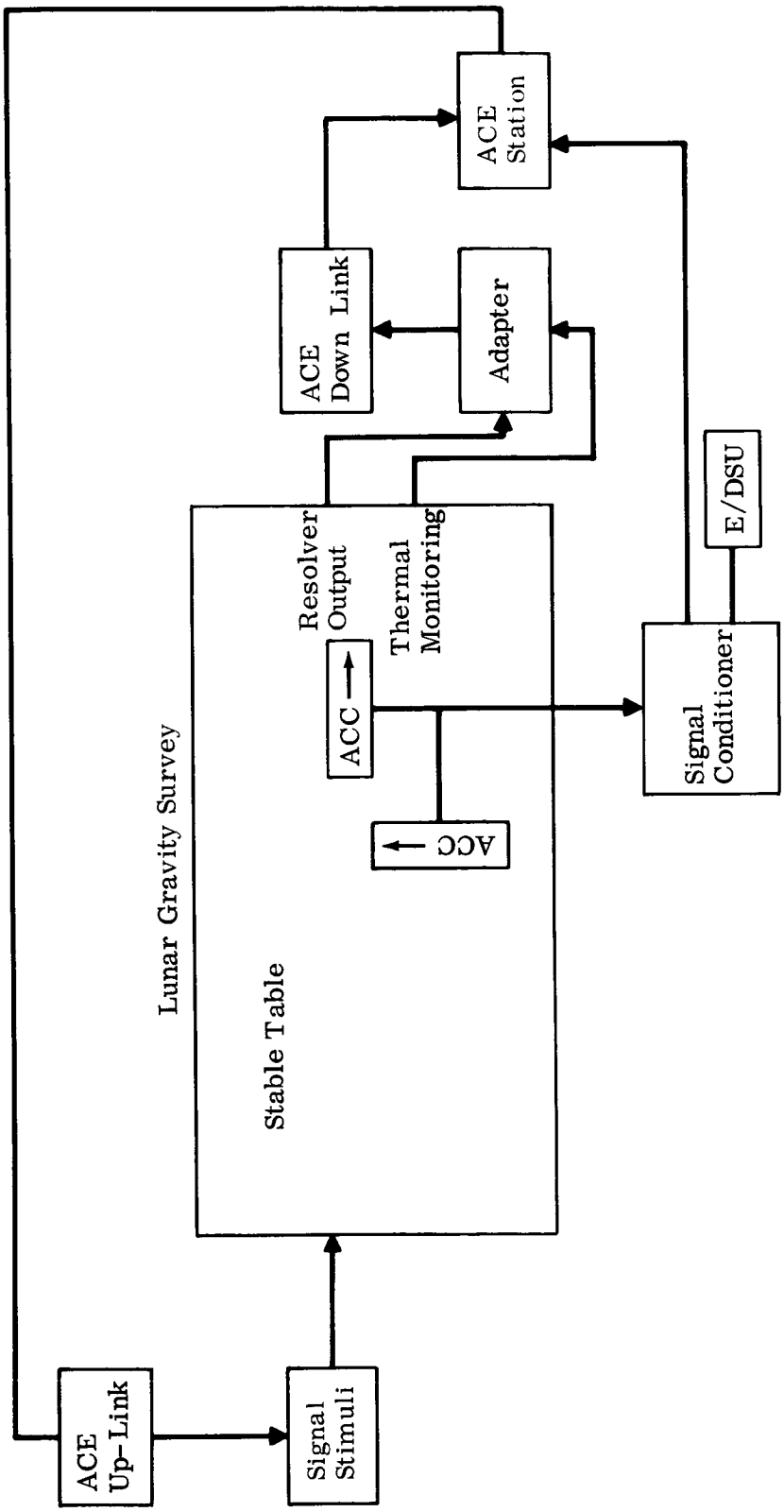


Figure 6.5-12 Lunar Gravity Survey GSE Functional Block Diagram, Flights 507/511

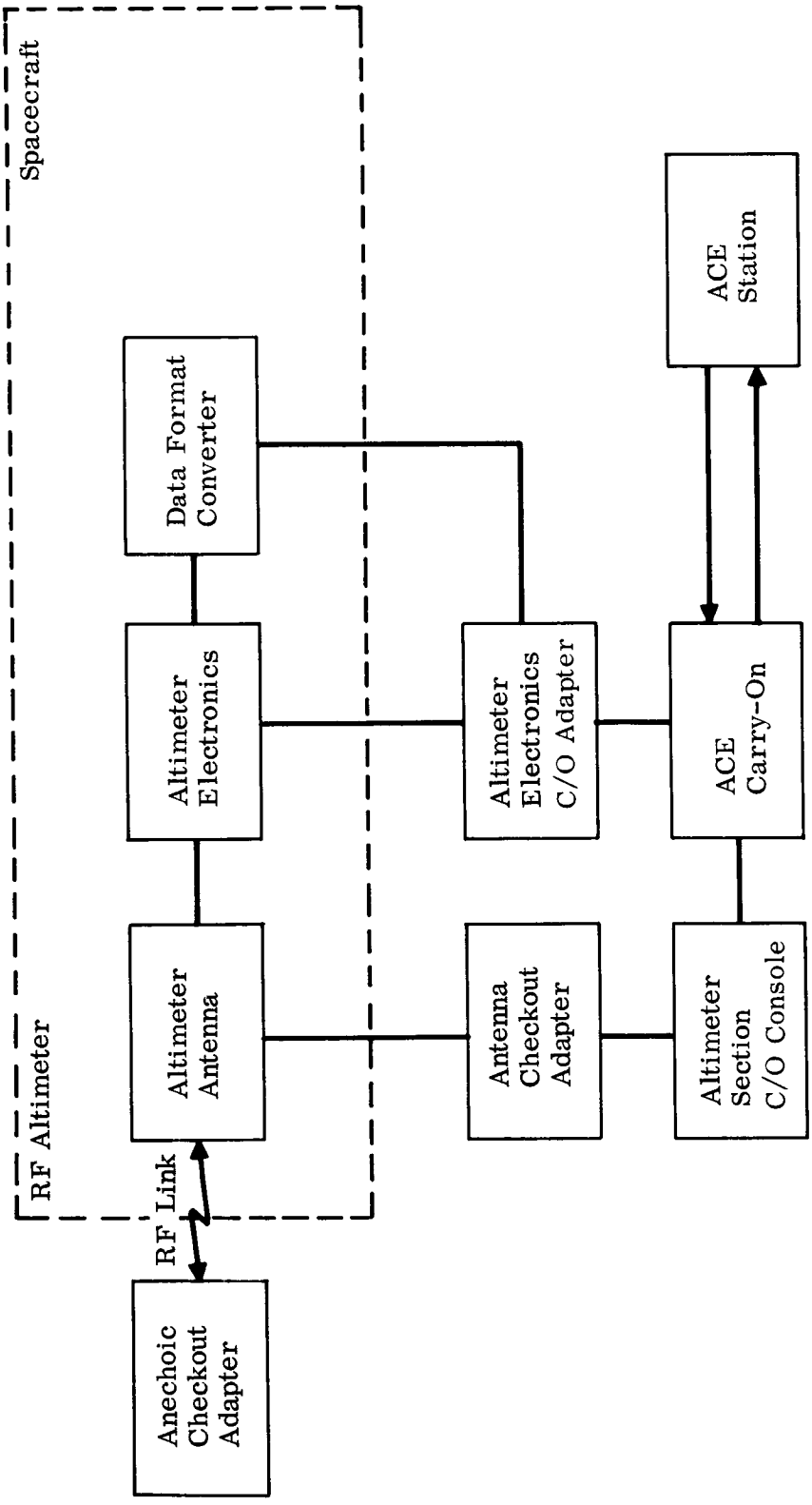


Figure 6.5-13 Radio Frequency Reflectivity GSE Functional Block Diagram, Flights 507/511

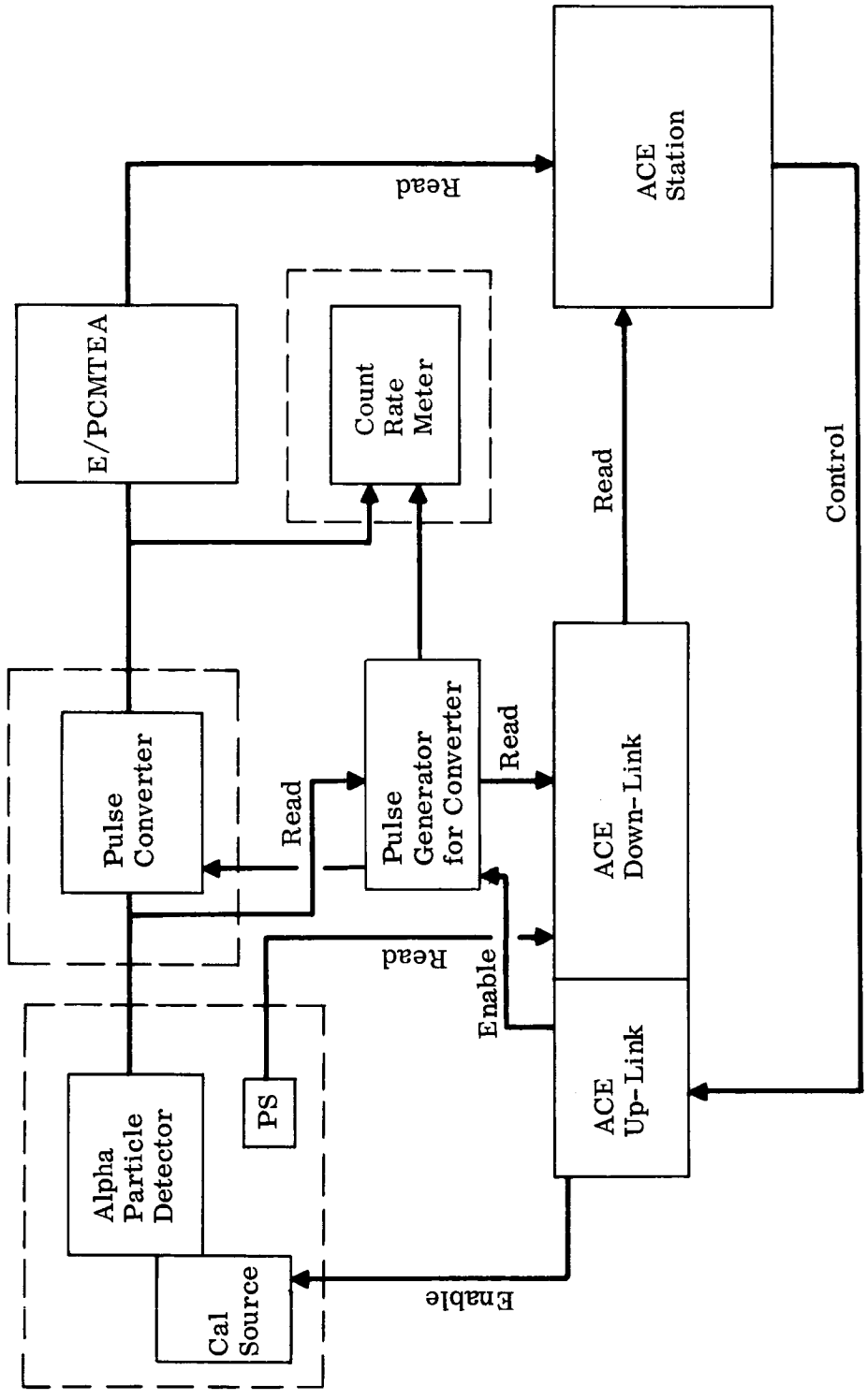


Figure 6.5-14 Alpha-Emission from Lunar Surface GSE Function Block Diagram, Flights 507/511

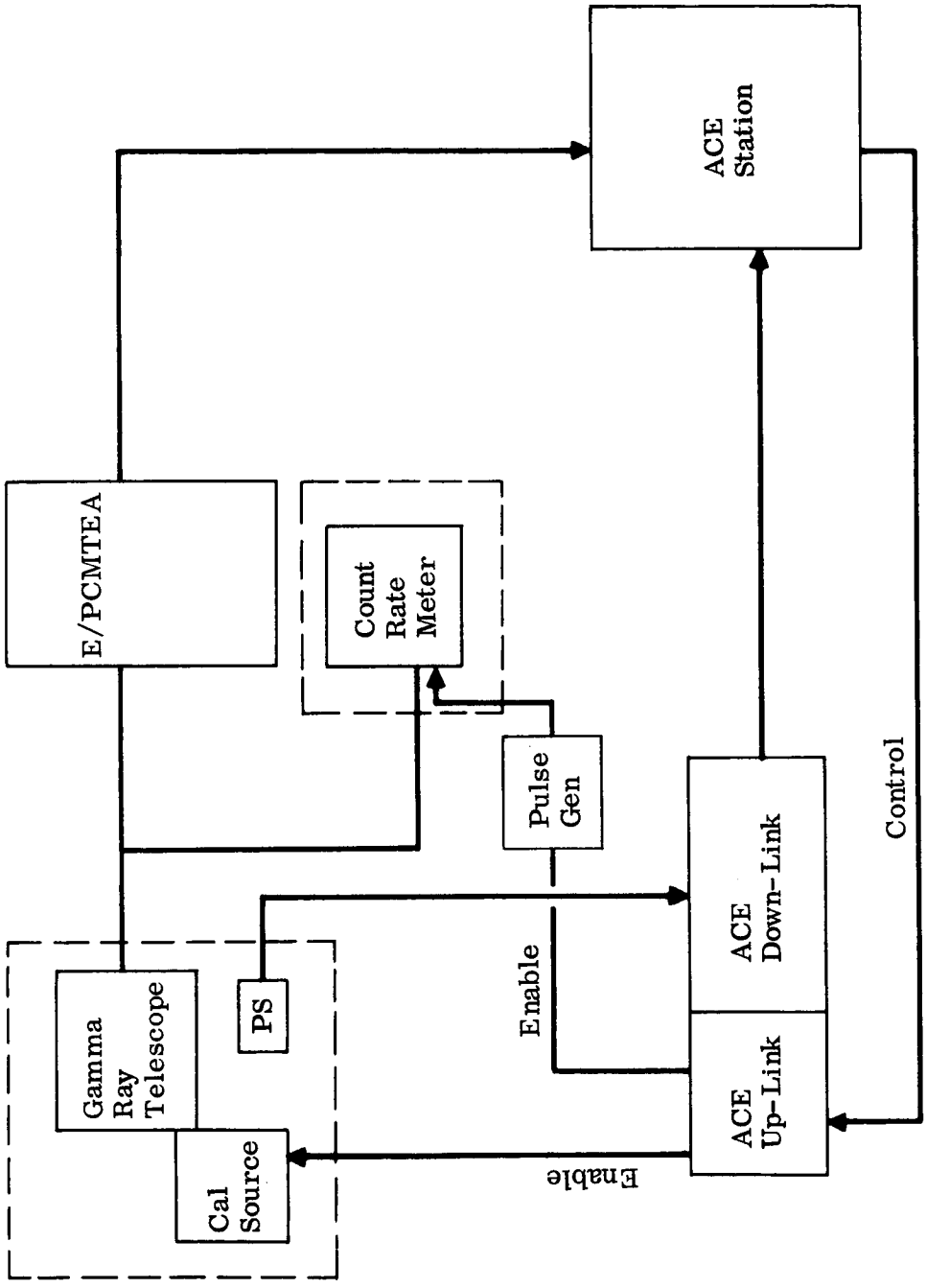


Figure 6.5-15 Gamma-Ray Mapping GSE Functional Block Diagram, Flights 507/511

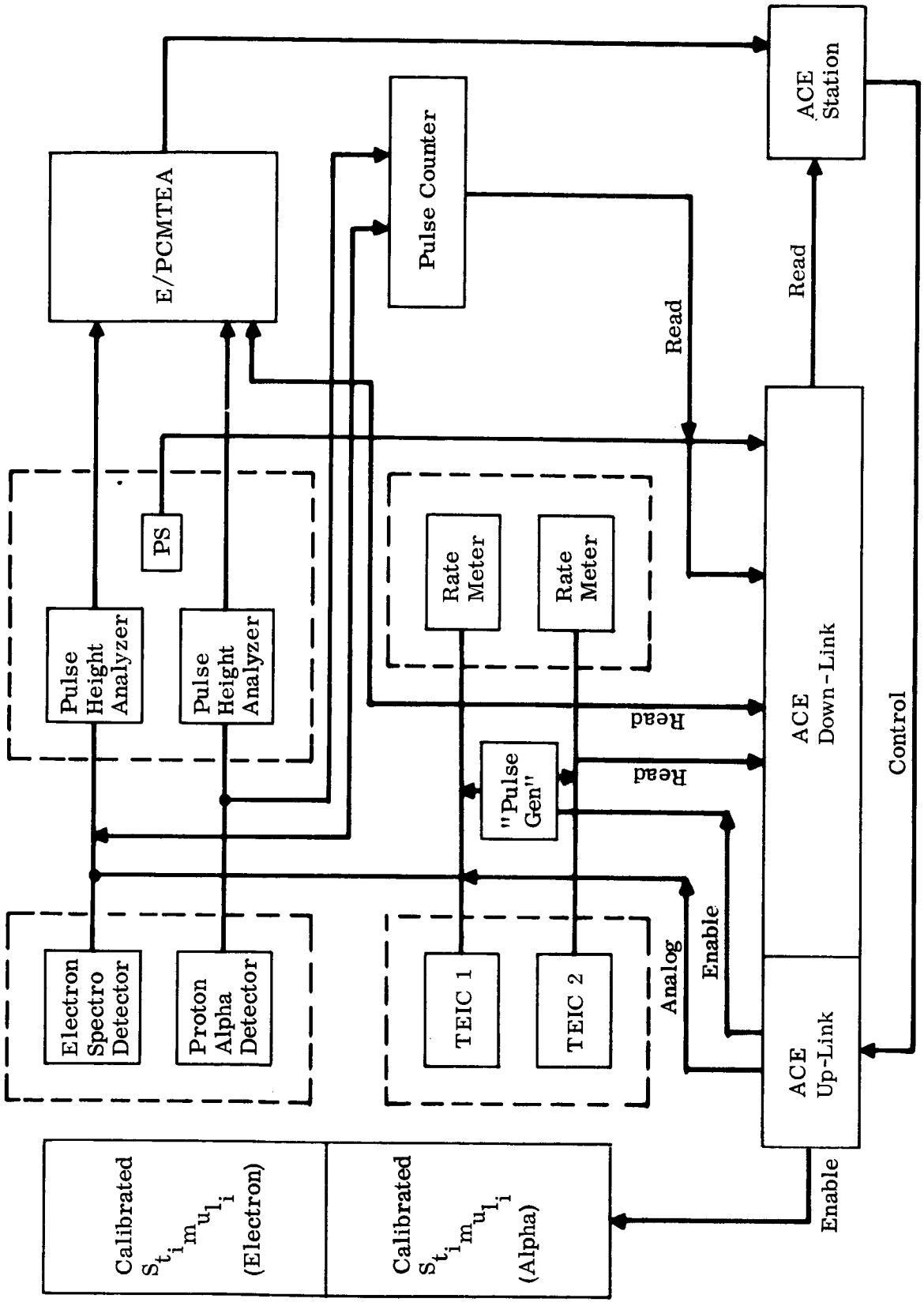


Figure 6.5-16 Radiation Monitoring GSE Functional Block Diagram
Flights 507/511

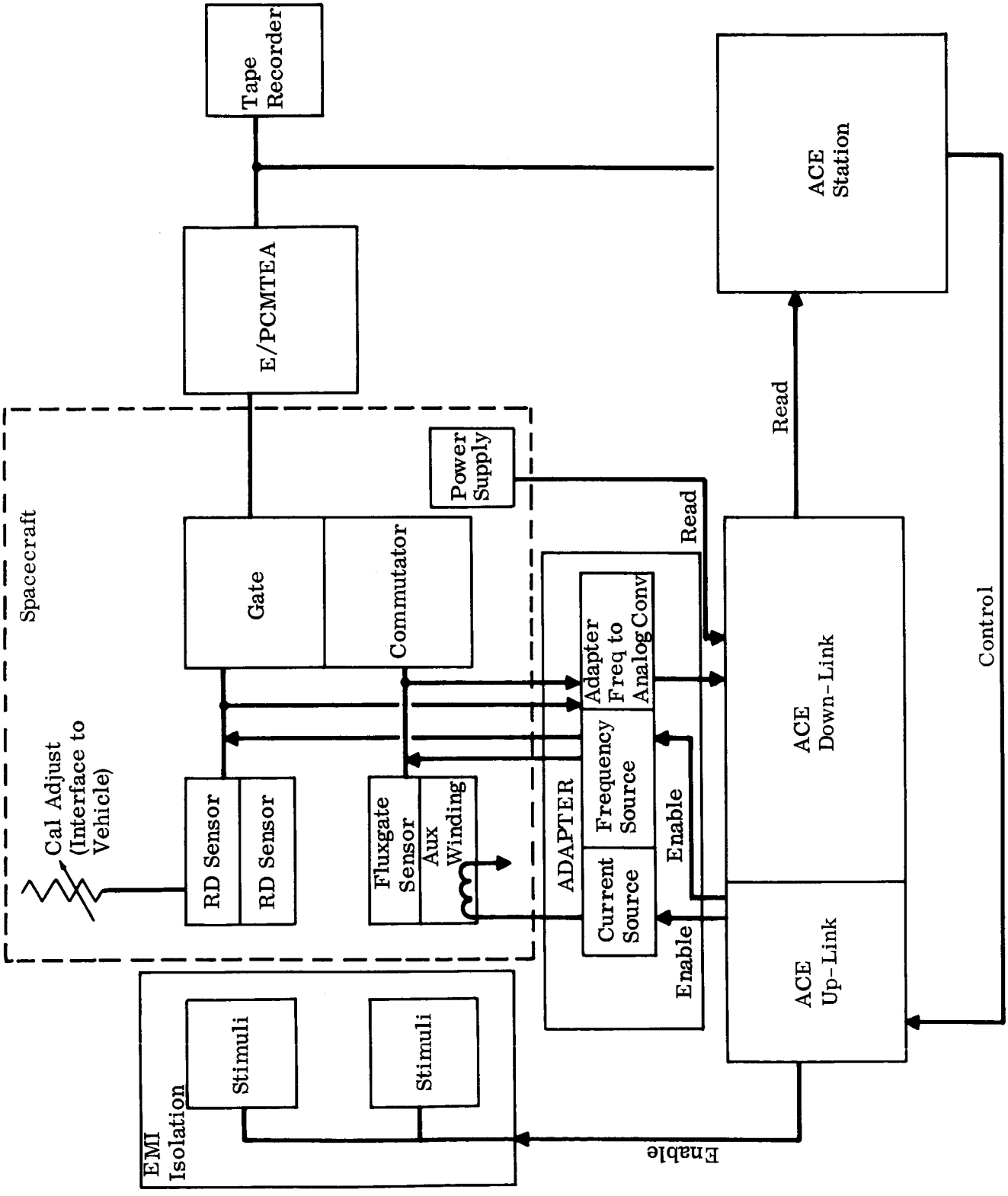


Figure 6.5-17 Magnetometer GSE Functional Block Diagram, Flights 507/511

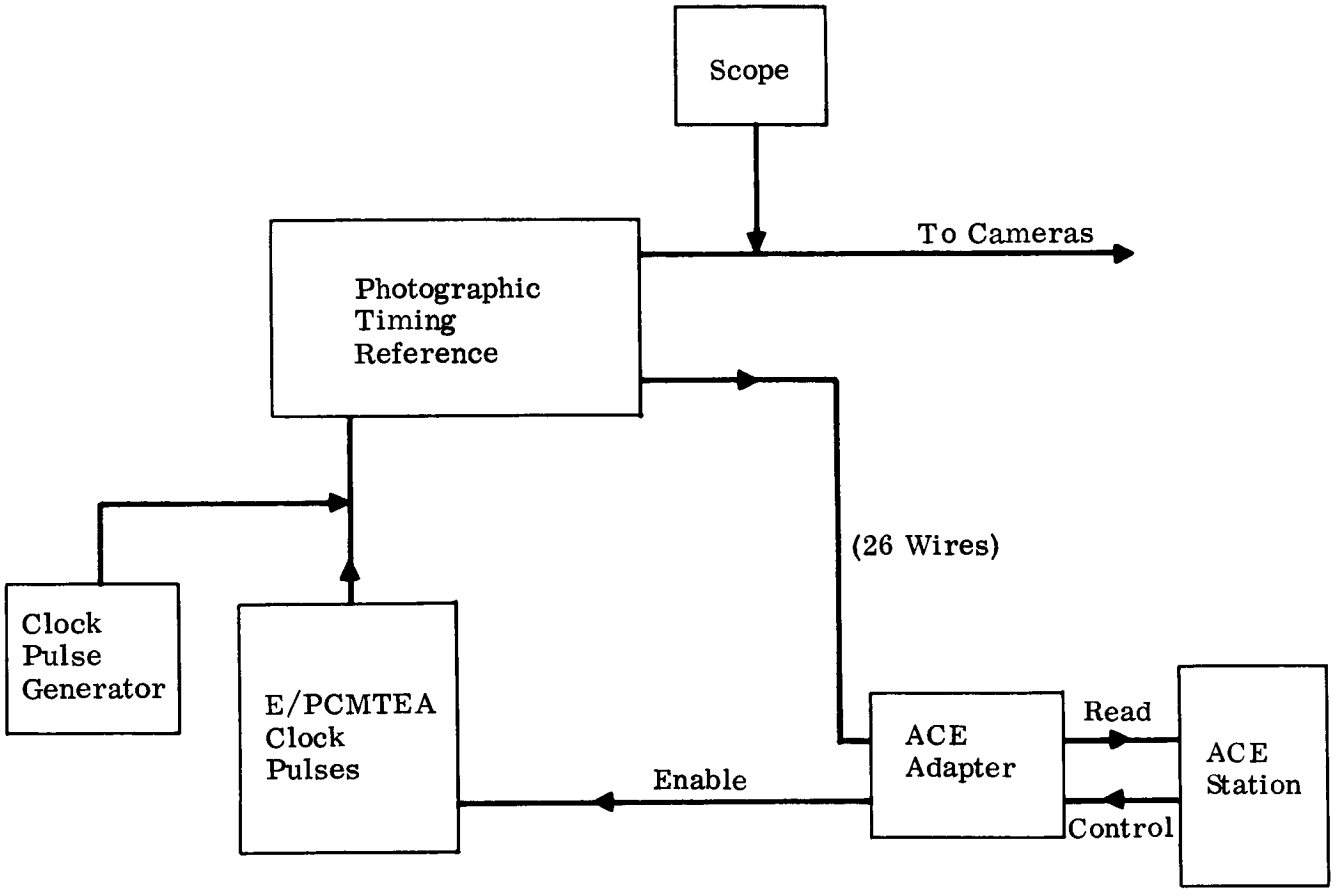


Figure 6.5-18 Photographic Timing Reference GSE Functional Block Diagram, Flights 507/511

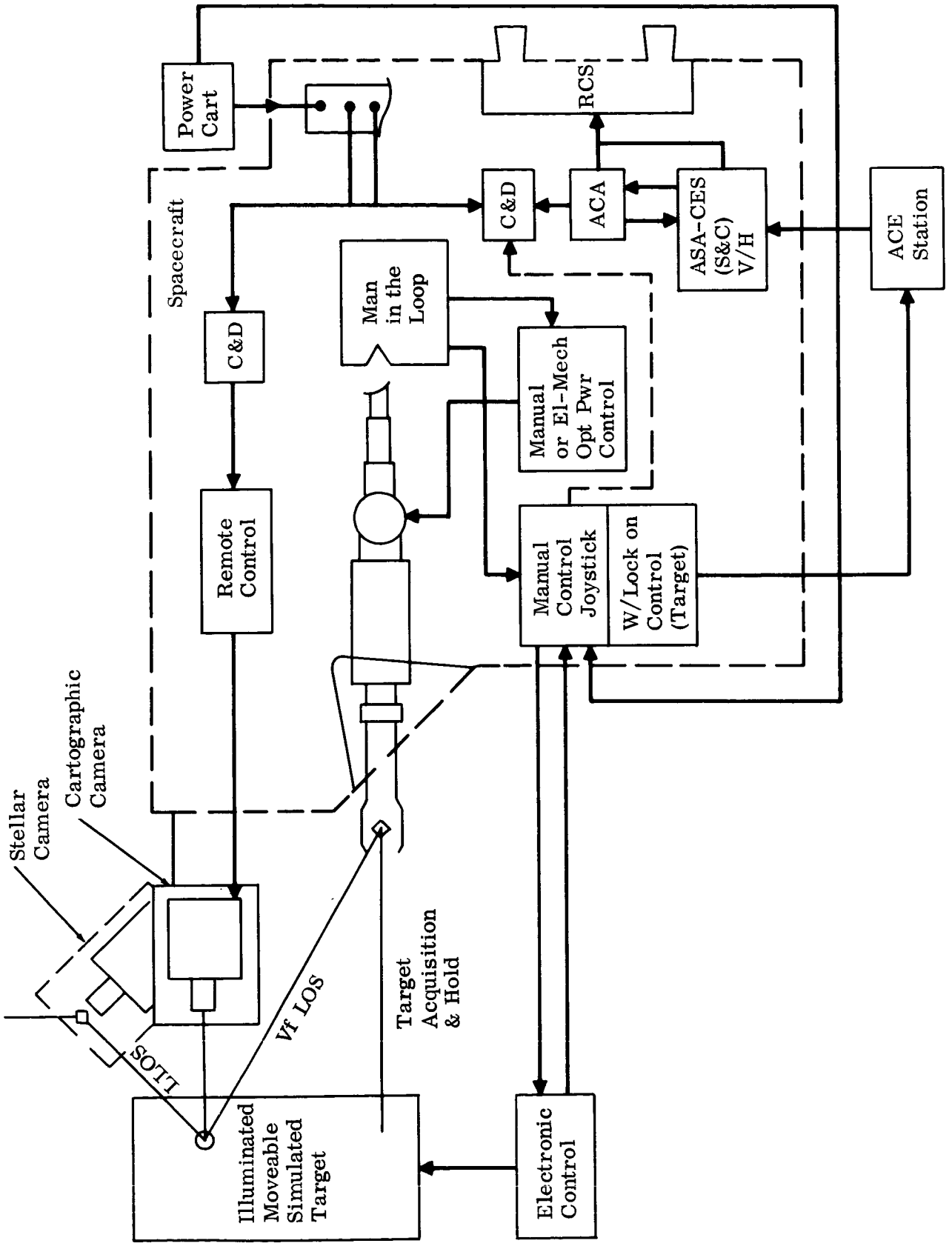


Figure 6.5-19 Metric Survey Photography GSE Functional Block Diagram, Flight 507/511

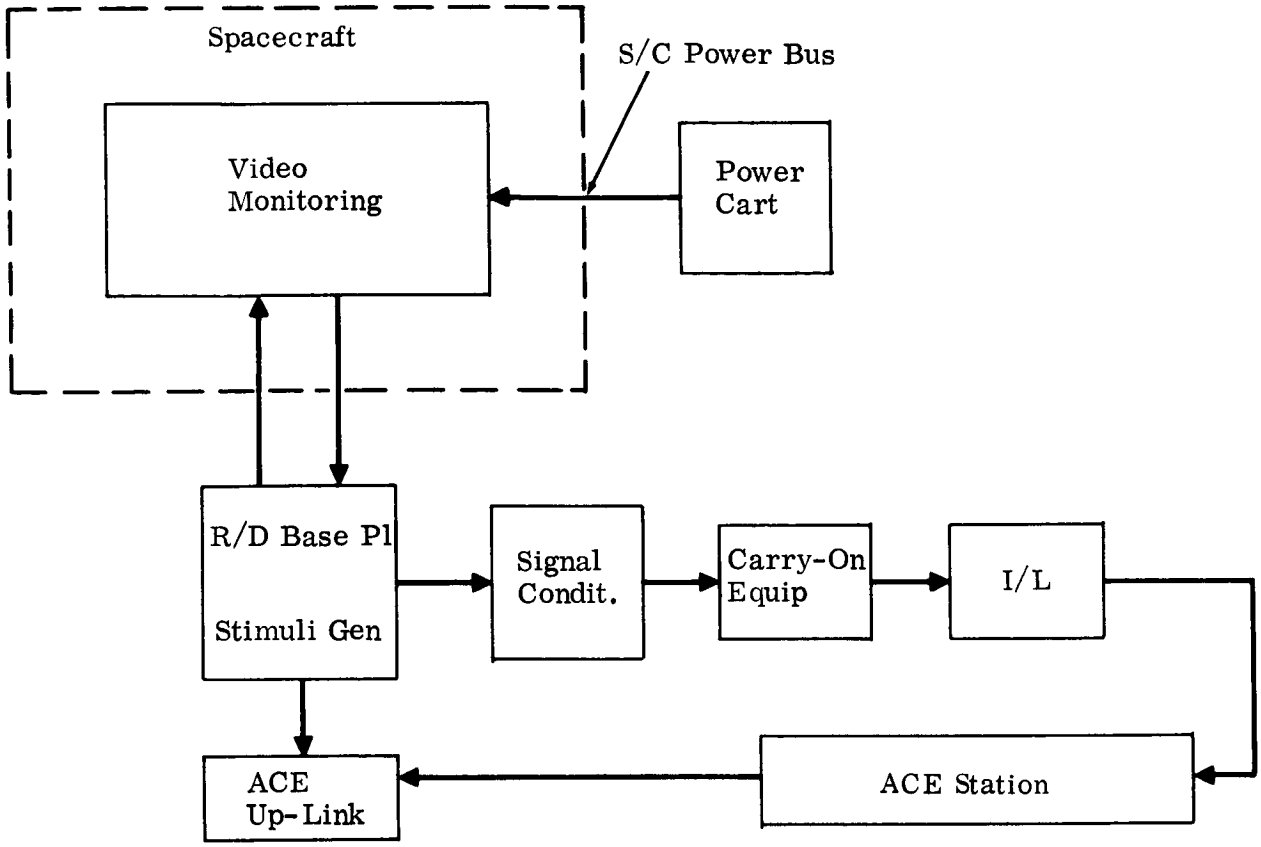


Figure 6.5-20 Video Monitoring GSE Functional Block Diagram, Flights 507/511

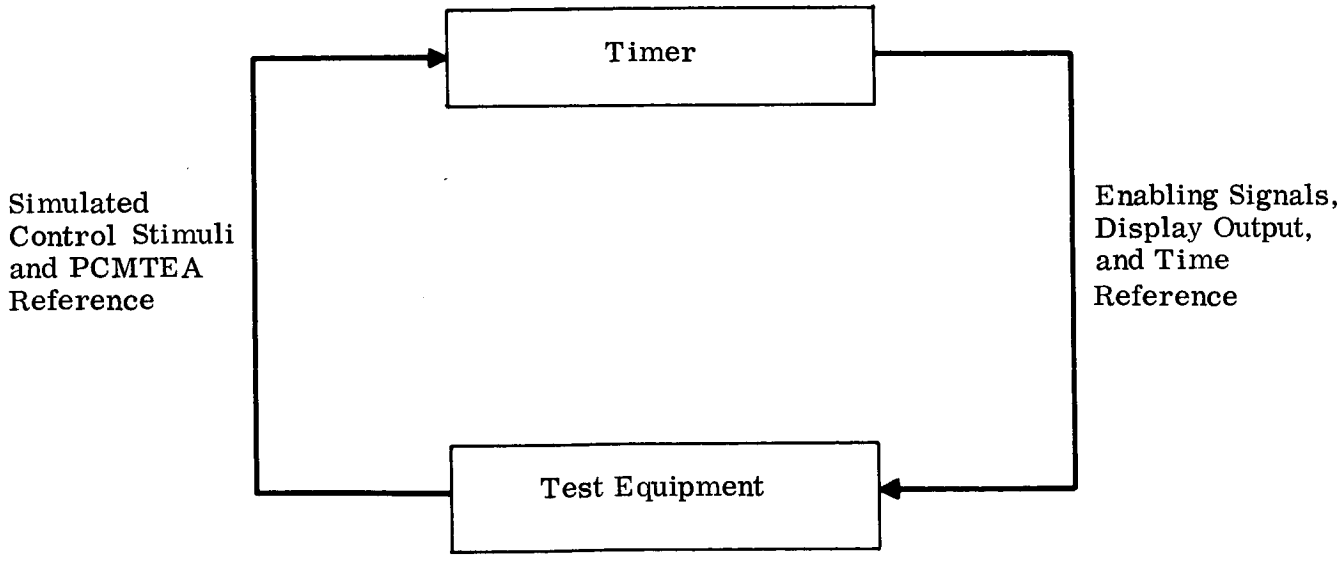

Timer
Simulated Control Stimuli and PCMTEA Reference
Enabling Signals, Display Output, and Time Reference
Test Equipment

Figure 6.5-21 Timer GSE Functional Block Diagram, Flights 507/511

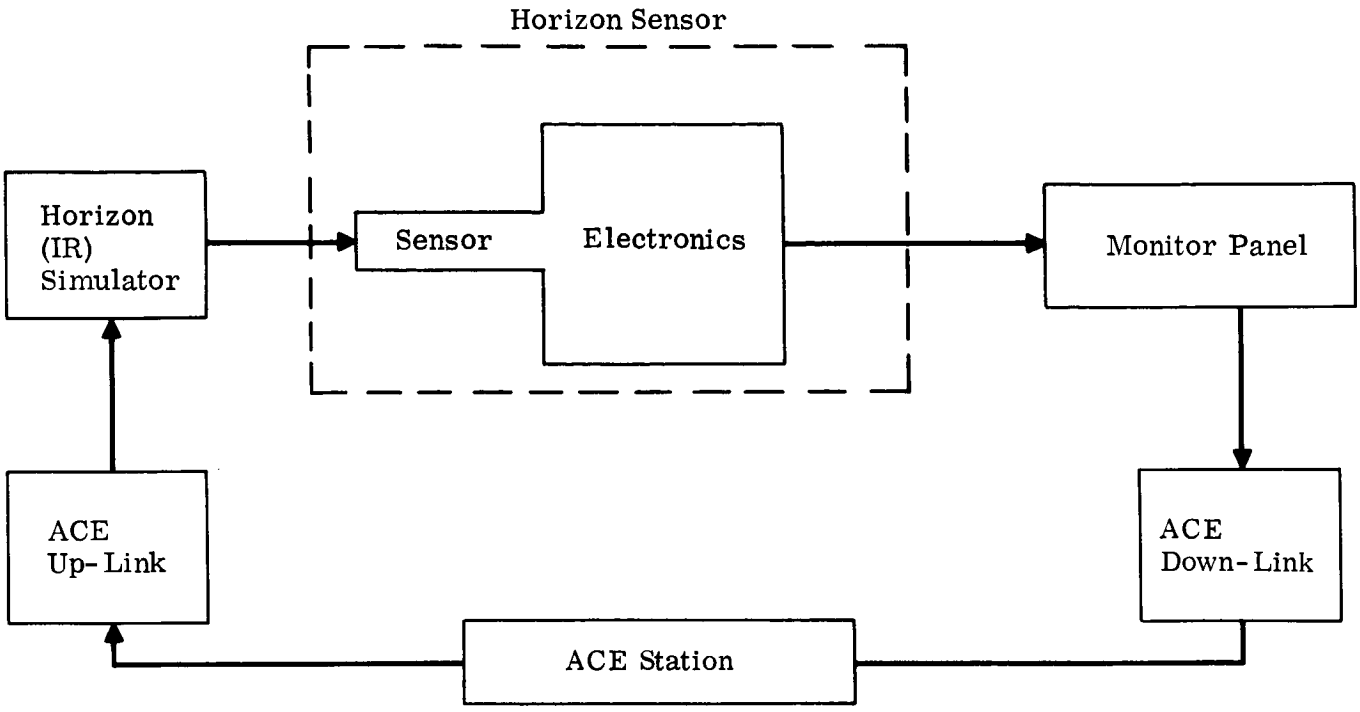


Figure 6.5-22 Horizon Sensor GSE Functional Block Diagram, Flights 507/511

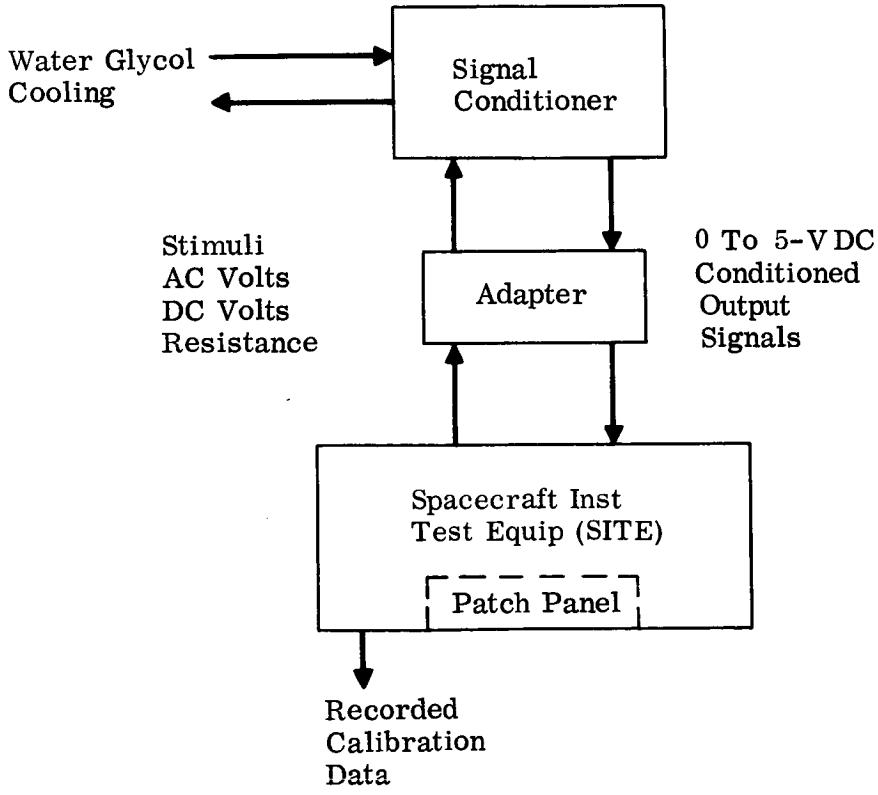


Figure 6.5-23 SITE Test of Signal Conditioner (Compatibility Equipment) GSE Functional Block Diagram, Flights 507/511

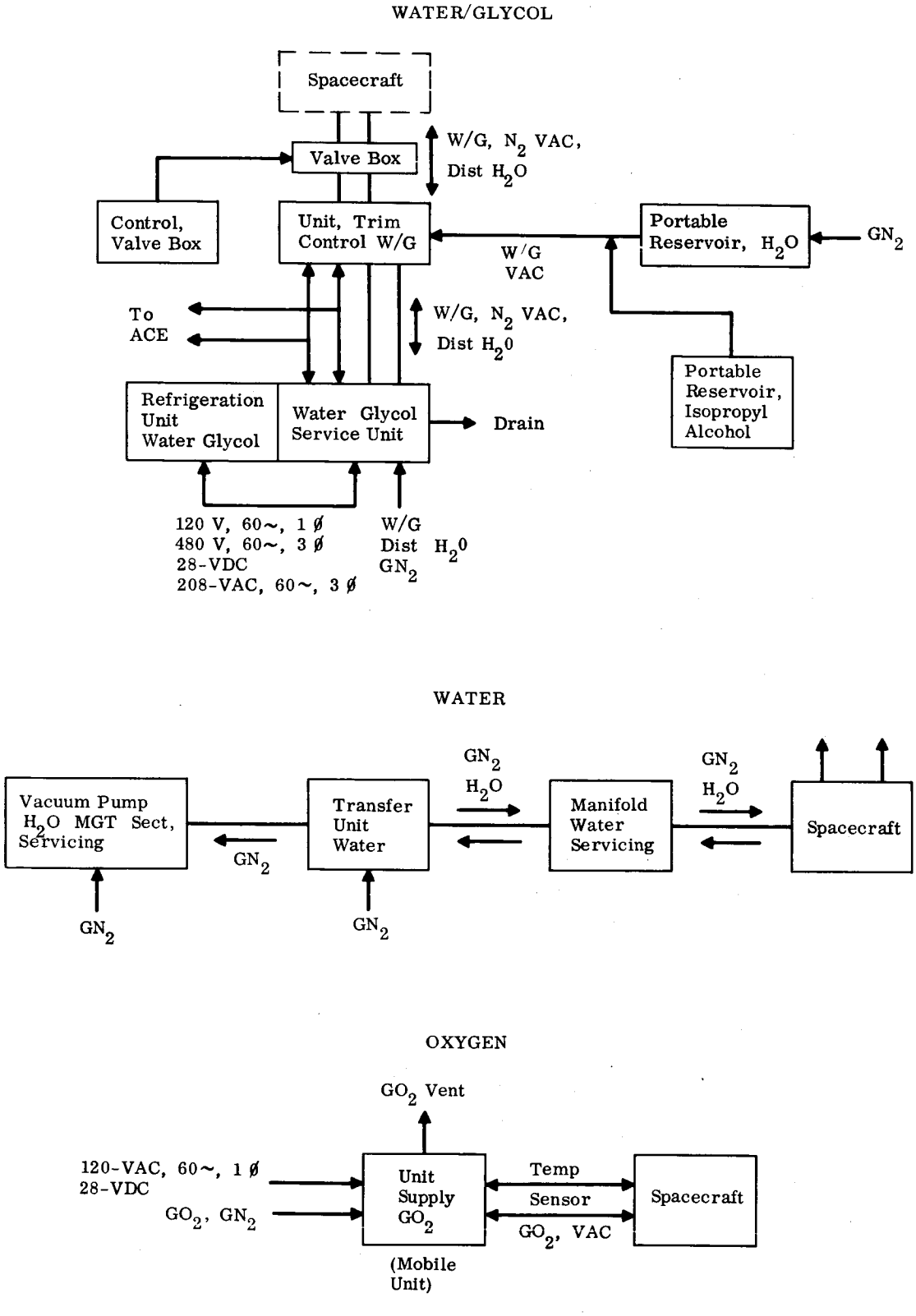


Figure 6.5-24 Environmental Control GSE Block Diagram, Flights 507/511

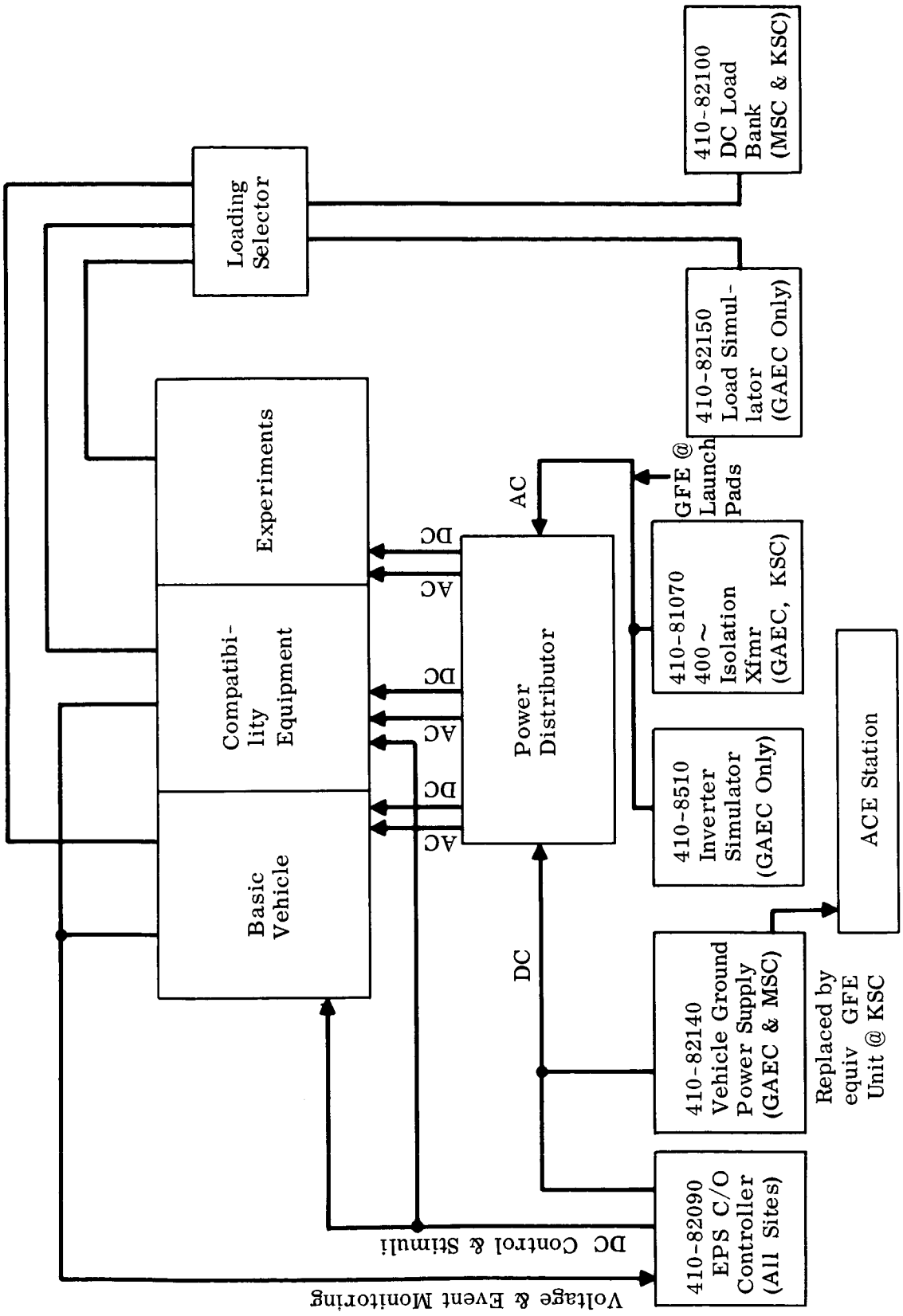


Figure 6.5-25 Electrical Power GSE Functional Block Diagram, Flights 507/511

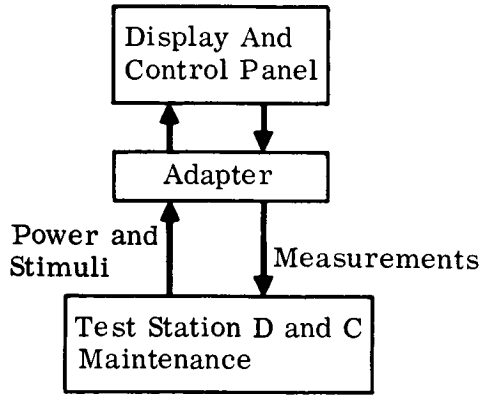


Figure 6.5-26 Displays and Controls GSE Functional Block Diagram, Flights 507/511

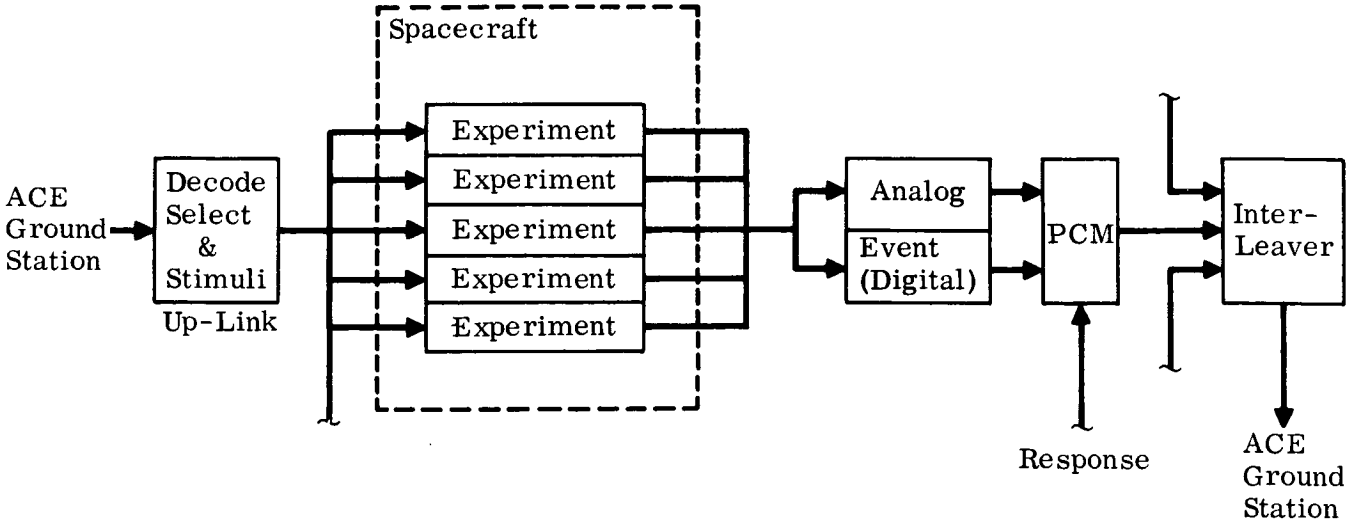


Figure 6.5-27 ACE Carry-On Equipment in Experiment Pre-Launch Checkout

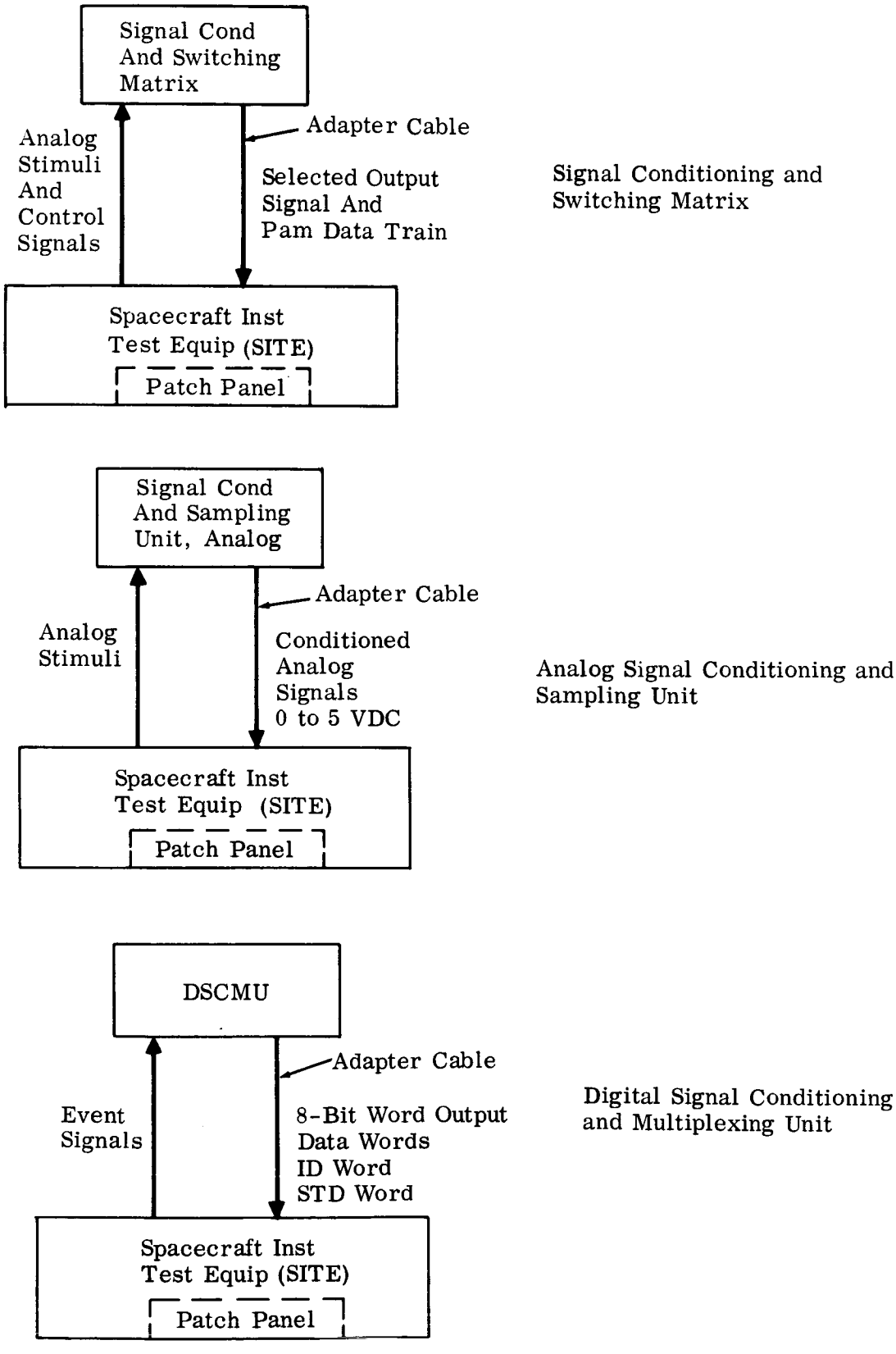


Figure 6.5-28 SITE Test of ACE Spacecraft Down-Link GSE Functional Block Diagram, Flights 507/511

7. FACILITIES PLAN

7.1 INTRODUCTION

7.1.1 Backround

This section presents a summary of the major facility requirements imposed by the Phase I Lab Payload Integration activities utilizing Grumman and government facilities. The information presented herein supplements that presented in the Facilities Plan, Volume XXI of the Phase B Final Report. During the course of the Payload Integration Addendum to the Phase B Study, the manufacturing, development testing, and prelaunch checkout activities for the Phase I Lab missions have been examined on a per mission basis. A major effort was directed toward assessing the facility requirements determined during Phase B studies, and uncovering any additional major requirements brought on by the Payload Integration tasks.

In summary, the facility requirements for the AES Phase I Labs and Integrated Payloads represent an effective utilization of existing and currently planned Apollo manufacturing, test, checkout, and launch facilities. The reported planning is based on the ML-65-1 NASA Launch Schedule for the interweaved Apollo manned Lunar Landing Program and Apollo Extension, Phase B Labs. The overall facility requirements will be continually monitored as the launch schedule and vehicle configuration are modified.

7.2 TEST FACILITIES

7.2.1 General

The discussion of test facilities in this plan complements Section 3 of the Facilities Plan, Volume XXI of the AES-LEM Phase B Final Report. It covers the additional use of test facilities to accomplish the experiment payload integration for the Phase I Lab missions. Utilization of these facilities is shown in the Loading Schedule, Figure 7.1-1.

7.2.2 Grumman Facilities

The types of facilities required are established by compatibility equipment development requirements and integration of payload experiments. An analysis of the schedule of tests, as shown in Figure 2.1-1, shows that no new types of facilities are required over those already existing at Grumman.

Utilization of existing Grumman facilities beyond those of the basic Phase B program are:

- Flight Control Integration Simulator
- Part Task and Full Mission Engineering Simulators
- Fuel Systems Laboratory (Cold Flow Facility)
- Hydrostatic Test Facility

Existing facilities that will be utilized for the payload integration effort which were discussed in the basic Phase B Program Report, Volume XX are:

- Environmental Laboratory: T/V chambers, shakers
- Environmental Control System Laboratory: Liquid Test Rig (LTR), Oxygen Supply Simulator (OSS), and Internal Environment Simulators (IES).
- Acceptance Checkout Equipment - Spacecraft (ACE-S/C)

As shown on the Facilities Loading Schedule, Figure 7.1-1, common utilization of the Environmental Control System (ECS) Laboratory and the ACE-S/C stations is required in the same time periods as the Phase B and Addendum Programs.

The slight increase in use of the ACE-S/C stations occurs at such times that minor modifications in scheduling might be made so that the three stations, identified as required by the Phase B Program, can handle the added load.

7.2.3 Government Test Facilities

The Test Plan and the Test Schedule show the requirement for use of the MSC Thermal Vacuum (T/V) Chambers A and B to support the Payload Integration test program and provide mission support.

No new facilities are required over those described in the Facilities Plan, Volume XXI of the Phase B Final Report. Figure 7.2-1 shows the additional projected utilization of the T/V Chambers.

7.3 MANUFACTURING FACILITIES

7.3.1 General

The following subparagraphs describe the major facility requirements to perform the payload integration tasks. The Facilities Plan, Volume XXI, and the Manufacturing Plan, Volume XVII, of the Phase B report described the LEM facilities and the additional requirements to modify the Phase I Labs at KSC.

Only the assembly operations and directly related minor fabrications tasks are planned for KSC. Fabrication of detailed parts for both the modification and compatibility kits is to be done at Bethpage.

7.3.2 Use of KSC for Modification and Payload Integration

This Payload Integration study requires that the payload integration as well as the LEM-to-Lab modification be performed at KSC. Since the modification and payload integration are to be accomplished in parallel, an estimate of the facility requirement was made for the combined task. Additional area over and above that required for modification is needed for unpacking, storage, and checkout of experiments, as shown in Figure 7.3-1.

A detailed study of the available information on building plans for KSC indicates potential use of areas that exist or are planned to be built for the Apollo Program. Availability will be dependent on:

- Permission for use of NASA KSC facilities
- Schedule
- Interface with the LEM Program
- Minor revisions of layouts presently planned for LEM
- Availability of area in the MSOB now assigned to Gemini

Figure 7.3-2 shows a layout of a portion of the MSOB now planned for LEM and Gemini and how it might be used for this task.

Since LEM requirements for the area are of relatively short duration, it is possible that scheduling adjustments could be made if necessary.

Considerable shop equipment, such as tube benders and brazing equipment that are now available at Bethpage, will have to be provided at KSC.

7.3.3 Use of Bethpage Facilities

The extensive facilities at Bethpage (Volume XXI) will be available for work on mock-ups, modification, and compatibility kits, as well as vehicles. No requirements for floor space or equipment are indicated over the existing LEM facilities and the additional facilities, described in the Phase B study report, for manufacturing of hardware or GSE.

7.3.4 Bethpage as an Alternate Manufacturing and Payload Integration Site

The facilities described in previous subparagraphs are based on performing the payload integration in parallel with the modification of LEM's to AES Phase I Labs in NASA facilities at KSC.

A study which compared the requirements for performing the tasks at Bethpage as compared with KSC revealed some points for consideration from the standpoint of facilities.

Since the study was based on the integrated manufacturing schedule (Volume XVII, Phase B Study), it became apparent that the Grumman (Bethpage) Facility is almost fully utilized building the eight vehicles per year required by the schedule. To modify vehicles without interruption of the schedule would require the assignment of additional space for the modification task at Bethpage. Thus, if vehicles were to be modified either at Grumman or KSC, new area must be provided. Less area will be required at Grumman than at KSC because some work stations at Bethpage which are only moderately loaded, can be made available. Paragraph 4.2.2 of this volume presents an analysis of three alternate cases as related to manufacturing and facilities. The three alternatives are:

- A LEM capable of performing the lunar landing mission is shipped to KSC for modification and installation of the required systems and experiments.
- A LEM capable of performing the lunar landing mission is modified at the Grumman (Bethpage) before shipment to KSC for launch.
- Modifications and installation of systems required by the AES missions are installed during the structural huildup and final assembly of the spacecraft at Bethpage.

7.4 PRELAUNCH CHECKOUT AND LAUNCH OPERATIONS

As described in detail in the Operations Plan, Section 5, no new facilities are required at KSC over those presented in the Phase B Final Report, Volume XVI. A review of the existing KSC facilities suggests use of the Pyrotechnics Integration Building for the weight and balance determination since the capability for this function now exists in that building.

TEST FACILITY	MAJOR EQUIPMENT	1966 J F M A M J J A S O N D	1967 J F M A M J J A
Power Generation System (PGS) Lab	T/V Chamber Phase II Lab Rig, H_2 Rig, O_2 Rig, Shelter Rig, Special Test Benches, & Phase II Lab Rig		
Flight Controls Integration (FCI) Lab		Software, Counter-Rotating Platform	509 507/511 509
Drop Test Facility			
Mechanical Sys Lab			
Environmental Lab	T/V Chamber - 15' x 28', P = $1x10^7$ MM Hg with Test Article, LN_2 Cooled to -300°F, Closed Ckt. TV & Instrumentation T/V Chamber - 4' x 8' P = $1x10^{-8}$ mm Hg with Test Article LN_2 Cooled to -300°F & Fully Instrumented. T/V Chamber - Size to be Determined Shaker - 4-way 10,000-lb Multi-Shaker System Shaker - 12,000-lb Shaker System Shaker - 30,000-lb Force Shaker System 5-2000 Cps Siuusoidal, 15-20,000 Cps Random & Seismic Block Isolation. Shaker - 1200-lb, 5-3000 Cps		507 507/511 509
Environmental Control Sys Lab	Liquid Test Rig (LTR) Oxygen Supply Simulator (OSS) Internal Environment Simulator (IES) Hydrostatic Test Facility	507/511	507/511 509 214 214
Electronic Sys Lab			
Acceptance Checkout Equipment - S/C (ACE-S/C)	Note: Loading Shown Here Includes Both LEM and AES Programs ACE Stations 4 3 2 1 0		
Fuel Systems Lab (Cold Flow Facility)	Helium Pressurization System, Blast Proof Test Cells, Flow Benches, Clean Room, and Data Acquisition System		507 LSV
Systems Simulation Lab	Part Task Simulator, Full Mission Engineering Simulator (FMES)	507/511 Viewfinder Evaluation	509 Ext. Rod Perform. Orb Opti

7.1-1-1

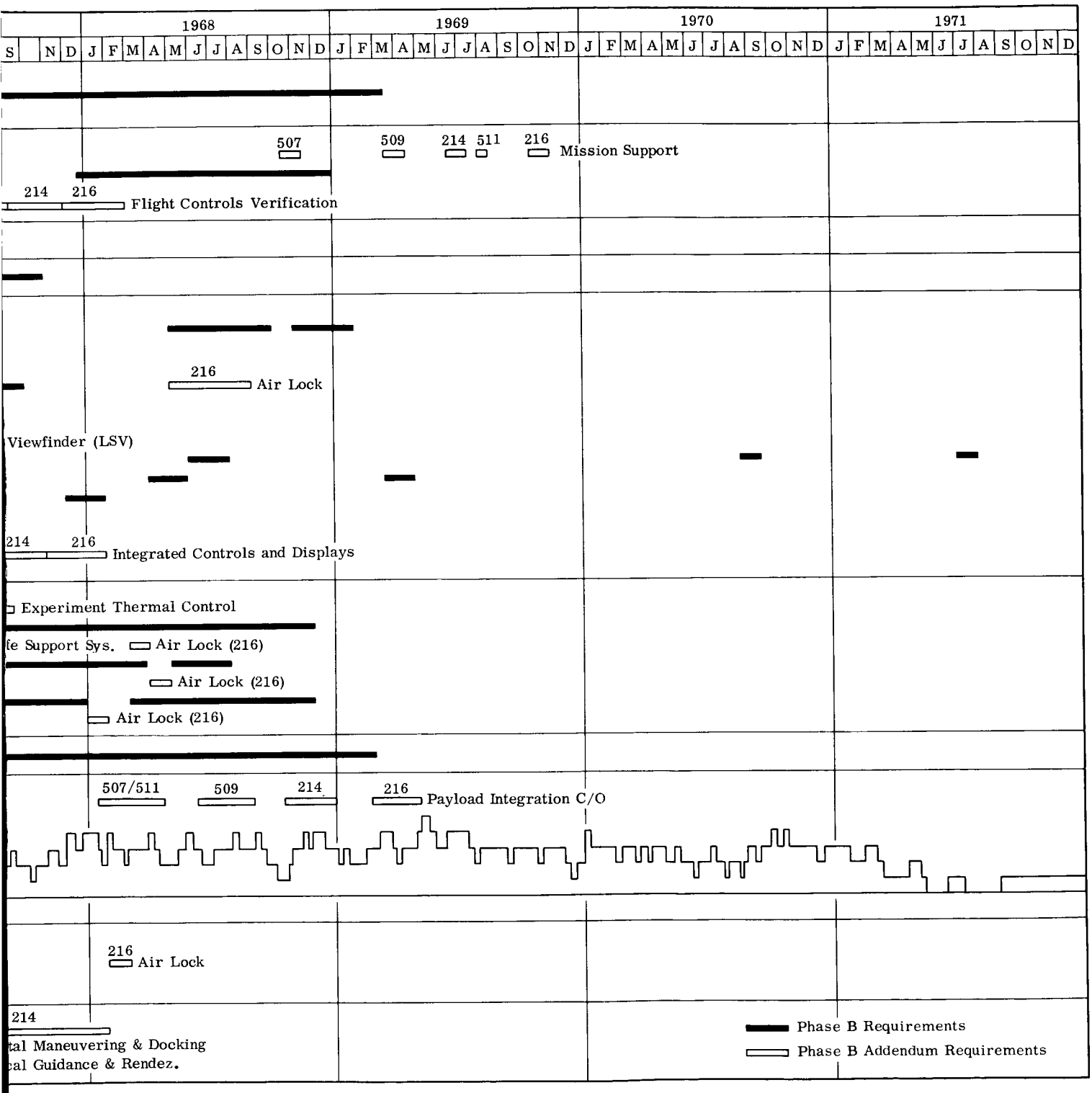


Figure 7.1-1 Grumman Facilities Loading Schedule

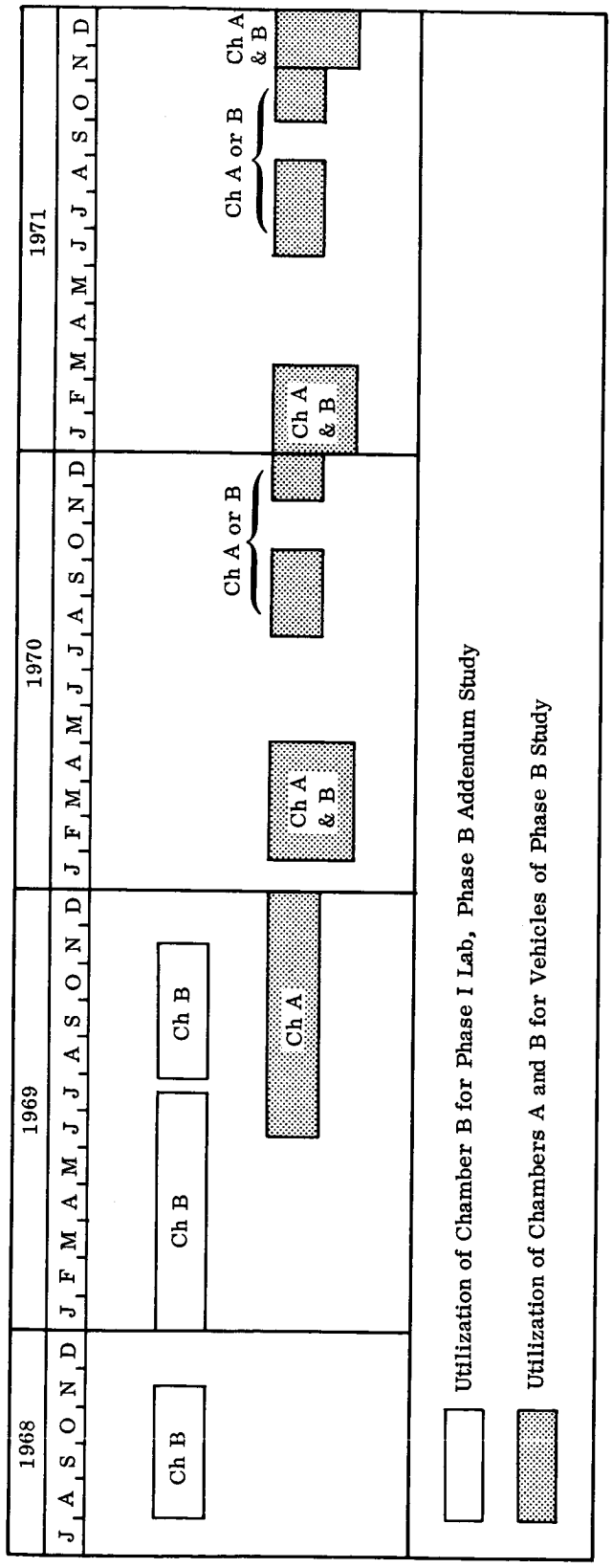

1968
1969
1970
1971
J A S O N D
J F M A M J J A S O N D
J F M A M J J A S O N D
J F M A M J J A S O N D
Ch B
Ch B
Ch B
Ch A
Ch A & B
Ch A or B
Ch A or B
Ch A & B
Utilization of Chamber B for Phase I Lab, Phase B Addendum Study
Utilization of Chambers A and B for Vehicles of Phase B Study

Figure 7.2-1 MSC Thermal Vacuum Chambers A and B Utilization

AES MANUFACTURING FACILITY AREA REQUIREMENTS

for

LEM TO PHASE I LAB MODIFICATION AND INTEGRATION

Purpose	High Bay	Low Bay	Office	Total Area Required
Production Administration	-	-	1500	1500
Store and Unpack	4300	3900	100	8300
Rotate and Clean	1000	-	-	1000
Ascent Work Station (2)	2000	-	300	2300
Descent Work Station (2)	3000	-	300	3300
Vibration	1000	-	-	1000
Weight & Center of Gravity	1000	-	-	1000
Alignment EMI	1200	-	-	1200
Shop Area - Bench	-	1500	200	1700
Shop Area - Equipment	-	2000	-	2000
Shop Area - Stock	-	3000	-	3000
Shop Area - Clean	-	1500	-	1500
ACE	-	3000	-	3000
Cold Flow	1000	1000	-	2000
Aisles	1300	1500	200	3000
TOTAL AREA REQUIRED (FT^2)	15, 800	17, 400	2600	35, 800

Figure 7.3-1 AES Manufacturing Facility Area Requirements for LEM to Phase I Lab Modification and Payload Integration

Grumman

Southwest Corner of Operations and Checkout Building at KSC

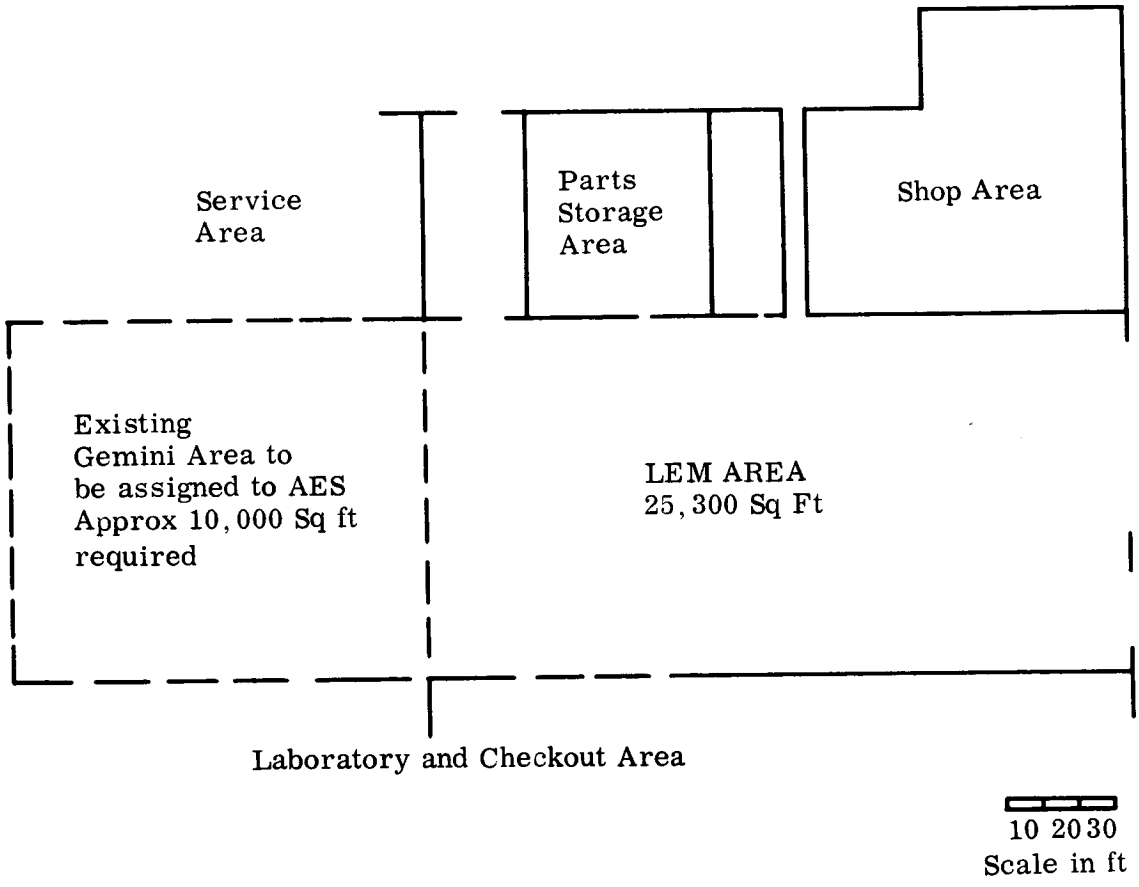


Figure 7.3-2 Proposed Area in the Operations and Checkout Building at KSC to Modify LEM to AES Phase I Lab and to Integrate Payloads

APPENDIX A

SUPPORT EQUIPMENT LIST

APPENDIX A

INTRODUCTION

This Appendix containes the Support Equipment List which is consistent with the parameters set forth in the AES Phase B Final Report, Volume XXV, Section 3, with the exception of the following paragraphs.

Quantities of Equipment Required Per Site

All Support Equipment Requirements for the Integration that have been identified to date, have been designated as applicable for each of the following sites:

- MSC - Manned Spacecraft Center, Houston
- ETR - Eastern Test Range, Cape Kennedy
- Grumman - Grumman Aircraft Engineering Corporation and its subcontractors
- Total - Sum total of MSC, ETR, and Grumman

The numbers shown on the list are the quantities of the End Item of Support Equipment that are required at that site. The numbers shown in parenthesis represent those quantities required but which can be recycled from an earlier flight or experiment.

Quantity of Equipment Required by Vehicle (Flight)

The Support Equipment Requirements have been identified as applicable to each Flight in the following order: Flight 507, 509, 214, 511, and 216.

The Equipment List is subdivided within each Flight by each experiment and each set of compatibility equipment. The total equipment required for each flight, experiment or set of compatibility equipment is shown. The numbers in parenthesis represent those quantities required but which can be recycled from an earlier flight or experiment.

GUIDELINES

Numbering System

Existing Apollo part numbers will apply to those support equipment requirements proposed for the integration tasks. The following numbering system, broken down by major equipment area, has been initiated to cover end item Support Equipment which is unique to the Integration Program.

Type of Support Equipment	Assigned Number Block
Electronic	410-X0001 and up
Handling and Transportation	420-X0001 and up
Fluids	430-X0001 and up

Coding System

A coding system is used to identify each subdivision of the list and provides an easy method of cross reference between flights and experiments. For example:

- 507-E-3: Represents a list of required GSE for Flight 507, Experiment 3, Alpha-Emission.
- 507-C-1: Represents a list of GSE required for Flight 507, Compatibility Equipment for Metric Survey Photography.

- 507-M-1: Represents a list of required GSE for Flight 507 which is not uniquely identifiable to a particular experiment.

The entire list is subdivided as follows:

Code	Description
• Flight 507 Experiments	
507-E-1	X-Ray Fluorescence
507-E-2	Gamma Ray Mapping
507-E-3	Alpha Emission
507-E-4-A	Radiation Monitoring
507-E-4-B	Magnetometer
507-E-5	Remote Geochemical Sensing
507-E-6	UV Luminescence
507-E-7	Infra-red survey
507-E-8-A	Panoramic Photography
507-E-8-B	Multispectral Photography
507-E-8-C	Lunar Survey View Finder
507-E-9	Micrometeorite Collection and Detection
507-E-10	Lunar Survey Probe
507-E-11	Passive Microwave
507-E-12	RF Reflectivity
507-E-13-A	Radar Imagery
507-E-13-B	Altimeter
507-E-14	Lunar Gravity Survey
• Flight 507 Compatibility Equipment	
507-C-1	Metric Survey Photography
507-C-2	Horizon Sensor
507-C-3	Video Monitoring
507-C-4	Photographic Timing Reference
507-C-5	Heat Transfer Section
507-C-6-A	Electrical Power Subsystem
507-C-6-B	Timer
507-C-7	Controls and Displays
507-C-8	Signal Conditioner
• Flight 507 Miscellaneous	
507-M-1	Support Equipment required for Flight 507 but not uniquely identifiable to a particular experiment.

- Flight 509 Experiments

509-E-1	Radiation Monitoring
509-E-2	X-Ray Astronomy
509-E-3	Martian Atmosphere Spectral Measurement
509-E-4	Comet Like Particulate Cloud
509-E-5	UV Image Converter
509-E-6	Radio Astronomy
509-E-7	Small Maneuvering Satellite
509-E-8	Extendible Rod
509-E-9	Magnetometer
509-E-10	Propellant Handling

- Flight 509 Compatibility Equipment

509-C-1	Environmental Cooling System
509-C-2	Counter Rotation Platform
509-C-3	Controls and Displays
509-C-4	Remote Cameras
509-C-5	Rendezvous Radar
509-C-6	Instrumentation
509-C-7	SMS Communications
509-C-8	Power Supply Subsystem

- Flight 509 Miscellaneous

509-M-1	Support Equipment required for Flight 509 but not uniquely identifiable to a particular experiment.

- Flight 214 Experiments

214-E-1	Radiation Monitoring
214-E-2	Control Moment Gyro
214-E-3	Optical Guidance System for Rendezvous
214-E-4	Deployment of RF Reflective Structure
214-E-5	On-Board Guidance and Navigation System
214-E-6	Orbital Maneuvering and Docking
214-E-7	Propellant Handling
214-E-8	Satellite Support Equipment

- Flight 214 Compatibility Equipment

214-C-1	Crew Provisions
214-C-2	Photographic
214-C-3	Guidance, Navigation and Control
214-C-4	Communications
214-C-5	Instrumentation

214-C-6	Electrical Power System
214-C-7	Environmental Control System
214-C-8	Controls and Displays
214-C-9	Structure

- Flight 214 Miscellaneous

214-M-1	Support Equipment Required for Flight 214 but not uniquely identifiable to a particular experiment.

- Flight 216 Experiments

216-E-1-A	Radiation Monitoring
216-E-1-B	Magnetometer
216-E-2	Capillarity
216-E-3	Extra Vehicular Activity - Spacesuit
216-E-4	Extra Vehicular Activity - Locomotion and maneuvering
216-E-5	Extra Vehicular Activity - Rescue Operations
216-E-6	Extra Vehicular Activity - Personnel and Cargo Transfer
216-E-7	EVA Support Equipment
216-E-8	Propellant Handling
216-E-9	Expandable Airlock
216-E-10	Extendible Rod

- Flight 216 Compatibility Equipment

216-C-1	Crew Provisions
216-C-2	Photographic
216-C-3	Communications
216-C-4	Instrumentation
216-C-5	Structure
216-C-6	Guidance, Navigation and Control
216-C-7	Electrical Power System
216-C-8	Environmental Control System
216-C-9	Controls and Displays
216-C-10	Propulsion

- Flight 216 Miscellaneous

216-M-1	Support Equipment Required for Flight 216 but not uniquely identifiable to a particular experiment.

Nature of Equipment

The following categories have been identified to date as applicable to each end item:

Column Heading	Original Apollo Derivation	Classification at start of Integration*	Integration* Requirement	Classification for Delivery under Integration*
LEM/Basic Add'l Unmod	Existing or Required for LEM or AES Baseline Program	GFE	Unmodified additional quantity	CFE
LEM/Basic Add'l Mod	Existing or Required for LEM or AES Baseline Program	GFE	Modified additional quantity	CFE
Integration New, CFE	New CFE, unique to Integration*	None	New Integration* Equipments	CFE
Integration New, GFE	New GFE, unique to Integration	None	New Integration* Equipment	GFE
GFE Unmod	Furnished by Grumman or other contractor, as CFE for LEM, AES Baseline AAL Experimenter, or other Apollo	GFE	Unmodified, No increase in Qty.	GFE
GFE Mod	Furnished by Grumman or other contractor, as CFE, for LEM AES Baseline, AAL Experimenter, or other Apollo	GFE	Modified, No increase in Qty.	GFE
GFE Add'l Unmod	Furnished by contractors other than Grumman for Apollo as CFE	GFE	Unmodified additional quantity	GFE
GFE Add'l Mod	Furnished by contractors other than Grumman for Apollo as CFE	GFE	Modified additional quantity	GFE

- - - - -

* Integration: Experiment integration of five Alternate Apollo LEM vehicles.

MISCELLANEOUS ADDITIONAL INFORMATION

Examination of existing Apollo Support Equipment resources has been made with an aim toward maximum utilization of existing equipment. Each end item of support equipment has been identified by the following code to illustrate the immediate supplier of this equipment to the AAL Experiment Integration contractor.

- L: LEM Program
- B: AES Baseline Program
- C: AAL Experiment Integration Contractor
- E: AAL Experimenter Contractor
- T: Other Apollo Program.

In addition, the following two codes have been used to further clarify the information presented.

- R: Equipment Recycled between sites, the quantity shown for each site being the maximum required at any one time at that site.
- M: Multiple modification is required between flights and/or experiments.

SUPPORT EQUIPMENT LIST

The list of equipment required for support of Experiment Integration is contained on the following pages.

FLIGHT 507-E-1
EXPERIMENT: X-RAY FLUORESCENCE

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0302	X-Ray Fluorescence Test Set	C173	G						3				1	1	1	3	E
410-X0303	Down Link Adapter	C173	M				3						1	1	1	3	C
410-X0324	Adapter, Electronics	C173	M				3						1	1	1	3	C
420-X0006	Sighting Equipt X-Ray		M				4						1	2	1	4	C
420-X0029	Alignment Gage, Solar X-Ray Det		G						3				1	1	1	3	E
420-X0030	Alignment Gage Lunar X-Ray Det		G						3				1	1	1	3	E

FLIGHT 507-E-2
EXPERIMENT: GAMMA RAY MAPPING

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0308	Gamma Test Set	C172	M						3				1	1	1	3	E
410-X0327	Adapter, Electronics	C172	M				3						1	1	1	3	C
420-X0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C
420-X0031	Dolly, Spectrometer		G						3				1	1	1	3	E
420-X0032	Alignment Gage, Spectrometer		G						3				1	1	1	3	E

FLIGHT 507-E-3
EXPERIMENT: ALPHA EMISSION

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0330	Alpha Emission Test Set	C171	G						3				1	1	1	3	E
410-X0323	Adapter, Electronics	C171	M				3						1	1	1	3	C
420-X0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C
420-X0033	Alignment Gage, Det Head		G						3				1	1	1	3	E

FLIGHT 507-E-4-A
EXPERIMENT: RADIATION MONITORING

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0304	Rad Monitor T/S	C174	G						4				1	2	1	4	E
410-X0305	Stimulii Adapter	C174	M				4						1	2	1	4	C
410-X0321	Adapter, Electronics	C174	M				4						1	2	1	4	C
420-X0001	Conditioning Equipt, Film		M				4						1	2	1	4	C
420-X0002	Handling Equipt, Film		M				4						1	2	1	4	C
420-X0003	Support Electron Source		M				4						1	2	1	4	C
420-X0004	Support Alpha Source		M				4						1	2	1	4	C
420-X0005	Alignment Gage, Spect		G						4				1	2	1	4	E
420-X0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C

FLIGHT 507-E-4-B
EXPERIMENT: MAGNETOMETER

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0301	Magnetometer Test Set	C165	G						4				1	2	1	4	E
	A-Electronics																
	B-EMI Isolation																
410-X0322	Adapter, Electronics	C165	M				4						1	2	1	4	C
420-X0076	Dolly, Magnetometer		G						4				1	2	1	4	E
420-X0077	Support Shielding		M				4						1	2	1	4	C

FLIGHT 507-E-5
EXPERIMENT: REMOTE GEOCHEMICAL SENSING

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0351	Calibrated Light Generator	A051	G	O					3				1	1	1	3	E
410-X0352	Differential Ampl Test Set	A051	G	O					3				1	1	1	3	E
420-X0006	See Flight 507-E-1	A052	M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0025	Dolly, Recon Head	A551	G	O					3				1	1	1	3	E
420-X0026	Alignment Gage, Res Head	A052	G	O					3				1	1	1	3	E

FLIGHT 507-E-6
EXPERIMENT: UV LUMINESCENCE

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0118	UV Exp Test Set	C157	G	O					3				1	1	1	3	E
410-X0125	Input Stimuli		G	O						3			1	1	1	3	E
420-X0001	See Flight 507-E-4-A		M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0006	See Flight 507-E-1		M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0028	Alignment Gage		G	O					3				1	1	1	3	E

FLIGHT 507-E-7
EXPERIMENT: IR SURVEY

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0117	IR Test Set	C156	G	O					3				1	1	1	3	E
410-X0126	Input Stimuli		G	O					3				1	1	1	3	E
420-X0006	Sighting Equipment		M	O			4						1	2	1	4	C
420-X0017	Sling, Cryo Tank		G	O					3				1	1	1	3	E
420-X0018	Dolly, Cryo Tank		G	O					3				1	1	1	3	E
420-X0019	Alignment Gage		G	O					3				1	1	1	3	E
420-X0020	Sling, Telescope Assy		G	O					3				1	1	1	3	E
420-X0021	Dolly, Telescope Assy		G	O					3				1	1	1	3	E
420-X0022	Installation Fixture		M	O			3						1	1	1	3	C
420-X0023	Alignment Gage		G	O					3				1	1	1	3	E
420-X0024	Alignment Gage		G	O					3				1	1	1	3	E

FLIGHT 507-E-8-A
EXPERIMENT: PANORAMIC PHOTOGRAPHY

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0525	Illuminated Moveable Simulated Target (IMST)		B				3						1	1	1	3	C
410-X0526	Computer-Programmed for IMST		B				3						1	1	1	3	C
410-X0527	Output Monitor Equipt		G						3				1	1	1	3	E
420-X0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C
420-X0010	Sling, Panoramic Camera		B				3						1	1	1	3	C
420-X0011	Dolly, Panoramic Camera		B				3						1	1	1	3	C
420-X0012	Fixture, Install., Pan. Cam.		M				3						1	1	1	3	C
420-X0013	Alignment Gage, Panoramic Camera		G						3				1	1	1	3	E

FLIGHT 507-E-8-B
EXPERIMENT: MULTISPECTRAL PHOTOGRAPHY

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0525	See Flight 507-E-8-A		B				(3)						(1)	(1)	(1)	(3)	C
410-X0526	See Flight 507-E-8-A		B				(3)						(1)	(1)	(1)	(3)	C
410-X0527	See Flight 507-E-8-A		G						(3)				(1)	(1)	(1)	(3)	E
420-X0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C
420-X0014	Sling, Multispectral Camera		B				3						1	1	1	3	C
420-X0015	Dolly, Multispectral Camera		B				3						1	1	1	3	C
420-X0016	Alignment Gage, Multi Camera		G						3				1	1	1	3	E

FLIGHT 507-E-8-C
EXPERIMENT: LUNAR SURVEY VIEW FINDER

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0525	See Flight 507-E-8-A		B				(3)						(1)	(1)	(1)	(3)	C
410-X0526	See Flight 507-E-8-A		B				(3)						(1)	(1)	(1)	(3)	C
420-X0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C
420-X0082	Alignment Gage, Viewfinder		G						3				1	1	1	3	E
420-X0083	Cover, Protective, Viewfinder		G						3				1	1	1	3	E
420-X0084	Sling, Viewfinder		B				3						1	1	1	3	C
420-X0085	Dolly, Viewfinder		B				3						1	1	1	3	C
420-X0086	Fixture, Installation, Viewfinder		G						3				1	1	1	3	E

FLIGHT 507-E-9
EXPERIMENT: MICROMETEORITE COLLECTION & DETECTION

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0354	Velocity Tube Output Gen	C051	GFE	O					3				1	1	1	3	E
410-X0355	Flux Detector Output Gen	C051	GFE	O					3				1	1	1	3	E
420-X0064	Sling, Tube, Ass'y	C551	GFE	O					3				1	1	1	3	E
420-X0065	Dolly, Tube Ass'y	C551	GFE	O					3				1	1	1	3	E
420-X0066	Equipt, Clean Handling	C551	M	O			3						1	1	1	3	C

FLIGHT 507-E-10
EXPERIMENT: LUNAR SURVEY PROBE
(Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0112	Adapter, Checkout, CSPDV Command Ant.	C154	M	O			3						1	1	1	3	C
410-X0113	Adapter, Checkout, CSPDV S-Band Ant.	C154	M	O			3						1	1	1	3	C
410-X0501	Controller-Ft & Cu		M				5						1	3	1	5	C
410-X0502	Test Tool- Cont		M				3						1	1	1	3	C
410-X0503	Cable Set Fluid Serv		M				5						1	3	1	5	C
410-32080-1	Adapter, Checkout VHF/UHF Ant.	C122	G	4					4				1	1	2	4	B
410-32150	Rack, Signal, Patching & Switching	C154	V	2						2			-	1	1	2	B
410-32280-5	Test Station, Comm S/S Maint	C126	V	5						5			1	2	2	5	B
420-X0006	See Flight 507-E-1		M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0068	Alignment Gage, LSP		G	O					3				1	1	1	3	E
420-X0069	Sling, LSP		G	O					3				1	1	1	3	E
420-X0070	Dolly, LSP		G	O					3				1	1	1	3	E
420-X0071	Fixture, Installation, LSP		M	O			3						1	1	1	3	C
420-X0072	Fixture, Checkout, LSP		M	O			3						1	1	1	3	C
420-X0073	Hand. Kit, Signal Proc		M	O			3						1	1	1	3	C
420-X0074	Hand. Kit, Trans VHF		M	O			3						1	1	1	3	C

FLIGHT 507-E-10
EXPERIMENT: LUNAR SURVEY PROBE
(Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
420-0075	Fixture, Boresight LSP		M	O			1						-	1	-	1	C
430-X0005	Fuel Storage Hydrazine		B				5						1	3	1	5	C
430-X0006	Fuel T&C/Unit		B				5						1	3	1	5	C
430-0007	Test Tool FC & TV		B				3						1	1	1	3	C
430-X0008	Ullage c/o Unit		B				5						1	3	1	5	C
430-X0009	Test Tool Ullage c/o Unit		B				3						1	1	1	3	C
430-X0010	Fuel Overlfow Unit		B				5						1	3	1	5	C
430-X0011	Test Tool Fuel o/f Unit		B				3						1	1	1	3	C
430-X0012	FDS-Hydrazine		M				5						1	3	1	5	C
430-X0013	Test Tool-Sys		B				3						1	1	1	3	C

FLIGHT 507-E-11
EXPERIMENT: PASSIVE MICROWAVE

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0119	Pass Micro Test Set	C158	G	O					3				1	1	1	3	E
410-X0124	Input Stimuli		G	O					3				1	1	1	3	E
420-X0006	See Flight 507-E-1		M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0034	Sling, Antenna Ass'y		G	O					3				1	1	1	3	E
420-X0035	Dolly, Antenna Ass'y.		G	O					3				1	1	1	3	E
420-X0036	Fixture, Installation		M	O			3						1	1	1	3	C
420-X0037	Alignment Gage		G	O					3				1	1	1	3	E
420-X0038	Sling, Antenna Ass'y		G	O					3				1	1	1	3	E
420-X0039	Dolly, Antenna Ass'y		G	O					3				1	1	1	3	E
420-X0040	Fixture, Installation		M	O			3						1	1	1	3	C

FLIGHT 507-E-12
EXPERIMENT: RF REFLECTIVITY

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0101	Adapter, Checkout, Alt Antenna	C151	M	O			3						1	1	1	3	C
410-X0102	Adapter, Checkout, Alt Electronics	C151	M	O			3						1	1	1	3	C
410-X0103	Console, Checkout Sta Alt. Section	C151	M	O			3						1	1	1	3	C
410-X0132	Adapter, Checkout, Anechoic, Altimeter Antenna	C151	M	O			3						1	1	1	3	C
420-X0041	Sling, Antenna		G	O					3				1	1	1	3	E
420-X0042	Dolly, Antenna		G	O					3				1	1	1	3	E
420-X0043	Fixture Installation		M	O			3						1	1	1	3	C
420-X0044	Sling, Ant. Coupler		M	O			3						1	1	1	3	C
420-X0045	Dolly, Ant. Coupler		M	O			3						1	1	1	3	C
420-X0046	Support, Ant. Coupler		M	O			3						1	1	1	3	C

FLIGHT 507-E-13-A
EXPERIMENT: RADAR IMAGERY

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0104	Adptr c/o Radar Ant	C152	M	O			3						1	1	1	3	C
410-X0105	Adptr c/o Radar Electronics	C152	G	O					3				1	1	1	3	E
410-X0106	Adptr c/o Anechoic Rad Ant.	C152	G	O					3				1	1	1	3	E
410-11760-1	C/O Sta Radar Sect	C152	V	1						1			-	1	-	1	B
410-11760-5	C/O Sta Radar Sect	C152	V	1						1			1	-	-	1	B
410-11760-7	C/O Sta Radar Sect	C152	V	1						1			-	-	1	1	B
420-X0006	See 507-E-1		M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0027	Alignment Gage		G	O					3				1	1	1	3	E
420-X0047	Sling, Imager Radar		G	O					3				1	1	1	3	E
420-X0048	Dolly, Imager Radar		G	O					3				1	1	1	3	E
420-X0049	Fixture, Boresight		M	O			1						-	1	-	1	C
420-X0050	Support, Ant. Coup Imager		M	O			3						1	1	1	3	C

FLIGHT 507-E-13-B
EXPERIMENT: ALTIMETER
(Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0107	Adptr c/o Anechoic Alt Ant.	C153	G	O					3				1	1	1	3	E
410-X0108	Adptr c/o Anechoic Alt Ant.	C153	G	O					3				1	1	1	3	E
410-X0109	Adptr c/o Alt Ant.	C153	G	O					3				1	1	1	3	E
410-X0110	Adptr c/o Alt Ant.	C153	G	O					3				1	1	1	3	E
410-X0111	Adptr c/o Alt Ant.	C153	G	O					3				1	1	1	3	E
410-11760-1	See Flight 507-E-13-A	C153	V	1						(1)			-	(1)	-	(1)	MB
410-11760-5	See Flight 507-E-13-A	C153	V	1						(1)			(1)	-	-	(1)	MB
410-11760-7	See Flight 507-E-13-A	C153	V	1						(1)			-	-	(1)	(1)	MB
420-X0006	See Flight 507-E-1		M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0049	See Flight 507-E-13-A		M	O			(1)						-	(1)	-	(1)	C
420-X0051	Alignment Gage		G	O					4				1	2	1	4	E
420-X0052	Sling, Alt Ant.		G	O					3				1	1	1	3	E
420-X0053	Dolly, Alt Ant.		G	O					3				1	1	1	3	E
420-X0054	Support, Ant. Coupler		M	O			3						1	1	1	3	C
420-X0055	Sling, Ant. Coupler		M	O			3						1	1	1	3	C
420-X0056	Dolly, Ant. Coupler		M	O			3						1	1	1	3	C
420-X0057	Alignment Gage		G	O					3				1	1	1	3	E
420-X0058	Sling, Alt Ant.		G	O					3				1	1	1	3	E
420-X0059	Dolly, Alt Ant.		G	O					3				1	1	1	3	E

FLIGHT 507-E-13-B
EXPERIMENT: ALTIMETER
(Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
420-X0060	Fixture Boresight		M	O			1						-	1	-	1	C
420-X0061	Support, Ant. Coupler		M	O			3						1	1	1	3	C
420-X0062	Sling, Ant. Coupler		M	O			3						1	1	1	3	C
420-X0063	Dolly, Ant. Coupler		M	O			3						1	1	1	3	C

FLIGHT 507-E-14
EXPERIMENT: LUNAR GRAVITY SURVEY

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0401	Signal Stimuli		M				3						1	1	1	3	C
410-X0402	Adapter, Electronics		M				3						1	1	1	3	C
410-X0403	BTME-Stable Platform		G						3				1	1	1	3	E
420-X0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C
420-X0067	Alignment Gage		G						3				1	1	1	3	E

FLIGHT 507-C-1
COMPATIBILITY EQUIPMENT: METRIC SURVEY PHOTOGRAPHY

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0525	See Flight 507-E-8-A		B				(3)						(1)	(1)	(1)	(3)	C
410-X0526	See Flight 507-E-8-A		B				(3)						(1)	(1)	(1)	(3)	C
410-X0527	See Flight 507-E-8-A		B				(3)						(1)	(1)	(1)	(3)	C
420-X0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C
420-X0007	Sling, Cartographic Camera		B				3						1	1	1	3	C
420-X0008	Dolly, Cartographic Camera		B				3						1	1	1	3	C
420-X0009	Alignment Gage, Cartographic Camera		G						3				1	1	1	3	E

FLIGHT 507-C-2
COMPATIBILITY EQUIPMENT: HORIZON SENSOR

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0409	Simulator, Horizon		G								3		1	1	1	3	T
410-X0410	Sim Test Horizon		G								3		1	1	1	3	T
410-X0411	Panel Mon Hor Sen		G								3		1	1	1	3	T
410-X0412	Tester, Hor Sen		G								3		1	1	1	3	T
420-X0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C
420-X0089	Fixture Align s/c Guid		G								3		1	1	1	3	T

FLIGHT 507-C-3
COMPATIBILITY EQUIPMENT: VIDEO MONITORING

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0120	VDU Test Set	C159	M	O			3						1	1	1	3	C

FLIGHT 507-C-4
COMPATIBILITY EQUIPMENT: PHOTOGRAPHIC TIMING REFERENCE

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0325	Adapter, Electronic	C166	M				3						1	1	1	3	C
410-X0309	Data Anot, Optical Adapt	C166	M				3						1	1	1	3	C
410-X0310	Pulse Generator	C166	M				3						1	1	1	3	C

FLIGHT 507-C-5
COMPATIBILITY EQUIPMENT: HEAT TRANSFER SECTION
(Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0528	Controller-H_2O/GLY Valve Box		M				5						1	3	1	5	C
410-X0529	Controller-H_2O Valve Box		M				5						1	3	1	5	C
410-X0530	Test Tool-H_2O/GLY Controller-V_1B_1		M				3						1	1	1	3	C
410-X0531	Test Tool-H_2O Controller-V_1B_1		M				3						1	1	1	3	C
410-X0532	Cable Set-H_2O/GLY Cont V_1B_1		M				5						1	3	1	5	C
410-X0533	Cable Set-H_2O/GLY Cont V_1B_1		M				5						1	3	1	5	C
430-X0001	Valve Box-H_2O/GLY		M				5						1	3	1	5	C
430-X0002	Valve Box-Water		M				5						1	3	1	5	C
430-X0003	GLY Sys Test Tool		M				3						1	1	1	3	C
430-X0004	H_2O Sys Test Tool		M				3						1	1	1	3	C
430-4100-1	Console-Space Unit & Press		G						3				1	1	1	3	L
430-4130-1	EMU Pre-Flt c/o Ass'y		G						3				1	1	1	3	L
430-4600-1	Simul Chamber		G						1				-	-	1	1	L
430-52010-1	Test Stand ECS Component Leak		G						3				1	1	1	3	L
430-52160-1	Test Stand-H_2O Components		G						3				1	1	1	3	L
430-52200-1	ECS c/o Adapt Kit		G						5				1	3	1	5	L
430-52210-1	Test Stand-H_2O & GLY Components		G						3				1	1	1	3	L

FLIGHT 507-C-5
COMPATIBILITY EQUIPMENT: HEAT TRANSFER SECTION (Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
430-54320-1	Vac Pump H_2O Mgt Sect		G						5				1	3	1	5	L
430-54340-1	Manifold-H_2O Servicing		G						5				1	3	1	5	L
430-54700-1	Unit-Trim Control, H_2O/GLY		G						5				1	3	1	5	L
430-94019-1	H_2O/GLY Serv Unit		G						5				1	3	1	5	L
430-94052-1	Cool Unit H_2O/GLY		G						5				1	3	1	5	L
430-94119-1	H_2O Trans Unit		G						5				1	3	1	5	L

FLIGHT 507-C-6-A
COMPATIBILITY EQUIPMENT: ELECTRICAL POWER SUBSYSTEM

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-8139	T/S 410-82140, 507-C-6	H015	G	1					1				-	-	1	1	B
410-8510	Inv Simulator	H015	G	1					1				-	-	1	1	B
410-81070	XFMR 1 Ph, Isol, 400 Cy.	H015	G	6					6				-	5	1	6	B
410-82090	Controller EPS c/o	H014	G	5						3			1	1	1	3	B
410-82100	Load Bank BAH c/o	H014	G	3						3			1	1	1	3	B
410-82140	Veh. Gnd Power Supply	H015	G	7					1				-	-	1	1	B
410-82150	Load Simulator	H016	G	2						1			-	-	1	1	B
410-82200	BTME, Power Dist	H018	G	3					3				1	1	1	3	B
410-82400	Test Sta, Batt Maint	H019	G	3						3			1	1	1	3	B
420-23219	Hand Fix D/S Battery		G						15				5	5	5	15	L
420-23220	Hand Fix ECA D/S		G						3				1	1	1	3	L

FLIGHT 507-C-6-B
COMPATIBILITY EQUIPMENT: TIMER

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0006	Timer BTE	H014	M	O			3						1	1	1	3	C

FLIGHT 507-C-7
COMPATIBILITY EQUIPMENT: CONTROLS & DISPLAYS

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0007	507 Adapt/410-42100-1 PNL 1	D001	M	0			3						1	1	1	3	C
410-X0008	507 Adapt/410-42100-1 PNL 3	D001	M	0			3						1	1	1	3	C
410-X0009	507 Adapt/410-42100-1 PNL 8	D001	M	0			3						1	1	1	3	C
410-X0010	507 Adapt/410-42100-1 PNL 10	D001	M	0			3						1	1	1	3	C
410-X0011	507 Adapt/410-42100-1 PNL 5	D001	M	0			3						1	1	1	3	C
410-X0012	507 Adapt/410-42100-1 PNL 2	D001	M	0			3						1	1	1	3	C
410-X0013	507 Adapt/410-42100-1 PNL 6	D001	M	0			3						1	1	1	3	C
410-X0014	507 Adapt/410-42100-1 PNL 11	D001	M	0			3						1	1	1	3	C
410-X0015	507 Adapt/410-42100-1 PNL 12	D001	M	0			3						1	1	1	3	C
410-42100-1	Test Sta, D&C Maint	D001	D	3						3			1	1	1	3	B
420-43001	Holding Ass'y, Control PNL	D501	G	7						3			1	1	1	3	B
420-43002	Holding Ass'y, Control PNL	D501	G	3						3			1	1	1	3	B
420-43003	Holding Ass'y, Control PNL	D501	G	3						3			1	1	1	3	B
420-43004	Holding Ass'y, Control PNL	D501	G	7						3			1	1	1	3	B
420-43005	Holding Ass'y, Control PNL	D501	G	7						3			1	1	1	3	B
420-43006	Holding Ass'y, Control PNL	D501	G	7						3			1	1	1	3	B
420-43007	Holding Ass'y, Control PNL	D501	G	3						3			1	1	1	3	B

FLIGHT 507-C-8
COMPATIBILITY EQUIPMENT: SIGNAL CONDITIONER

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0001	Adapt C/507/511 for 410-92405	G002	M	0			3						1	1	1	3	C
410-92405	See Flight 507-M-1	G002	G	3					(3)				(1)	(1)	(1)	(3)	B

FLIGHT 507-M-1
MISC EQUIP FOR FLT 507 (Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-E0006	Adapt Lab I/410-7900-1	G003	G	0					1				-	-	1	1	B
410-E0018	Exp Inst Stimuli Gen	G003	G	0					3				1	1	1	3	B
410-E0023	On-Board c/o Ass'y E/DSE	G004	G	0					2				-	1	1	2	B
410-X0042	Site Adapt/410-92211, Flt 507	G002	M	0			3						1	1	1	3	C
410-X0043	Site Adapt/410-92212, Flt 507	G002	M	0			3						1	1	1	3	C
410-X0044	Site Adapt/410-92213, Flt 507	G002	M	0			3						1	1	1	3	C
410-X0045	STE for 410-X0201, 507-M-1	G002	B	0			3						1	1	1	3	C
410-X0046	STE for 410-X0202, 507-M-1	G002	B	0			3						1	1	1	3	C
410-X0201	Time Packer/Multiplex	K004	B	0			3						1	1	1	3	C
410-X0202	Data Channel Selector	K004	B	0			3						1	1	1	3	C
410-7900-1	Inst Stimuli Generator	G003	G	1					3				1	1	1	3	B
410-9450	Patch Panel, Intercom	K004	G	1					1				-	-	1	1	B
410-9470	Operator's, Intercom	K004	G	51					21				-	-	21	21	B
410-9472	PWR Supply, Intercom	K004	G	3					2				-	-	2	2	B
410-9473	Feed-Thru, Intercom	K004	G	17					17				-	-	17	17	L
410-9480	Test Conductor, Intercom	K004	G	2					1				-	-	1	1	B
410-11170	Cable Set, Carry-on	K005	M	3						3			1	1	1	3	B
410-11990	ACE-S/C Gnd Station	K004	G	5						3			1	1	1	3	B
410-12731	Junction Box, Carry-On	K005	M	8						3			1	1	1	3	B

FLIGHT 507-M-1
MISC EQUIP FOR FLT 507 (Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-7260-1	On-Board c/o Ass'y DSEA	G004	G	2					2				-	1	1	2	B
410-92200	Rcvr Decoder & Baseplate	K005	A	8						3			1	1	1	3	B
410-92201	Dual Baseplate Unit	K005	A	8						3			1	1	1	3	B
410-92210	PCM- Sys	K005	G	8					3				1	1	1	3	B
410-92211	S/C & Multiplex Unit, Dig.	K005	A	8						3			1	1	1	3	B
410-92212	Sig Cond Unit, Analog	K005	A	8						3			1	1	1	3	B
410-92213	Sig Cond Unit, G&N	K005	A	8						3			1	1	1	3	B
410-92232	Interleaver	K004	G	7					5				1	3	1	5	B
410-92240	S/E Adaptr Monitor	K006	G	6					4				-	3	1	4	B
410-92241	Command Set	K006	A	5						4			-	3	1	4	B
410-92405	Spacecraft Inst Test Eqp.	G002	G	3					3				1	1	1	3	B

FLIGHT 509-E-1
EXPERIMENT: RADIATION MONITORING

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0304	See Flight 507-E-4-A	C174	G						(4)				(1)	(2)	(1)	(4)	E
410-X0305	See Flight 507-E-4-A	C174	M				(4)						(1)	(2)	(1)	(4)	C
410-X0321	See Flight 507-E-4-A	C174	M				4)						(1)	(2)	(1)	(4)	C
420-X0001	See Flight 507-E-4-A		G						(4)				(1)	(2)	(1)	(4)	E
420-X0002	See Flight 507-E-4-A		M				(4)						(1)	(2)	(1)	(4)	C
420-X0003	See Flight 507-E-4-A		M				(4)						(1)	(2)	(1)	(4)	C
420-X0004	See Flight 507-E-4-A		M				(4)						(1)	(2)	(1)	(4)	C
420-X0005	See Flight 507-E-4-A		G						(4)				(1)	(2)	(1)	(4)	E
420-X0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C

FLIGHT 509-E-2
EXPERIMENT: X-RAY ASTRONOMY

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0404	Alignment Gage		G						3				1	1	1	3	E
410-X0405	BTME-X-Ray Astronomy		G						3				1	1	1	3	E
420-X0090	Alignment Gage		G						3				1	1	1	3	E
420-X0091	Optical Sighting Equipt.		M				4						1	2	1	4	C
420-X0092	Target Source		G						4				1	2	1	4	E

FLIGHT 509-E-3
EXPERIMENT: MARTIAN ATMOSPHERE SPECTRAL MEASUREMENT

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0306	Martian Atmosphere T/S Optics	C170	G						3				1	1	1	3	E
410-X0307	Martian Atmosphere T/S Electronics	C170	G						3				1	1	1	3	E
410-X0320	Adapter, Electronics	C170	M				3						1	1	1	3	C
420-X0091	See Flight 509-E-2		M				(4)						(1)	(2)	(1)	(4)	C
420-X0093	Alignment Gage, Spec		G						3				1	1	1	3	E
420-X0094	Support, Optical Source		M				4						1	2	1	4	C
420-X0095	Dolly, Spectrometer		G						3				1	1	1	3	E

FLIGHT 509-E-4
EXPERIMENT: COMET LIKE PARTICULATE CLOUD

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0504	Controller		M				4						1	2	1	4	C
410-X0505	Test Tool Controller		M				3						1	1	1	3	C
410-X0506	Cable Set, Fluid Service		M				4						1	2	1	4	C
430-X0028	Fluid Stor Cond & Trans Unit		B				4						1	2	1	4	C
430-X0029	Valve Box		B				4						1	2	1	4	C
430-X0030	Test Tool Valve Box		B				3						1	1	1	3	C
430-X0031	System Test Tool		B				3						1	1	1	3	C
430-X0032	FDS		M				4						1	2	1	4	C

FLIGHT 509-E-5
EXPERIMENT: UV IMAGE CONVERTER

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0121	Image Conv T/S	C160	M	O			3						1	1	1	3	C
410-X0127	Input Stimuli		G	O						3			1	1	1	3	E
420-X0091	See Flight 509-E-2		M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0096	Alignment Gage		G	O					3				1	1	1	3	E
420-X0097	Support, Input Stimuli		M	O			4						1	2	1	4	C
420-X0098	Sling, Electro-Optic Unit		G	O					3				1	1	1	3	E
420-X0099	Dolly, Electro-Optic Unit		G	O					3				1	1	1	3	E

FLIGHT 509-E-6
EXPERIMENT: RADIO ASTRONOMY

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0114	Adptr Checkout, Radiometer Antenna	C155	M	O			3						1	1	1	3	C
410-X0115	C/O Station, Radiometer Section	C155	M	O			3						1	1	1	3	C
410-X0116	Adptr, C/O Radiometer Electronics	C155	M	O			3						1	1	1	3	C
420-X0091	See Flight 509-E-2		M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0100	Align, Gage Ant.		G	O					3				1	1	1	3	E
420-X0101	Sling, Antenna		G	O					3				1	1	1	3	E
420-X0102	Dolly Antenna		G	O					3				1	1	1	3	E
420-X0103	Fixture, Installation		M	O			3						1	1	1	3	C
420-X0104	Fixture, Checkout		M	O			3						1	1	1	3	C
420-X0105	Support, Ant. Coupler		M	O			4						1	2	1	4	C

FLIGHT 509-E-7
EXPERIMENT: SMALL MANEUVERING SATELLITE
(Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0510	Test Tool, Controller		M				3						1	1	1	3	C
410-X0513	Controller H_2O_2		M				5						1	3	1	5	C
410-X0514	Controller-O_2		M				5						1	3	1	5	C
410-X0515	Controller-Inert Gas		M				5						1	3	1	5	C
410-X0519	Cable Set H_2O_2 Service		M				5						1	3	1	5	C
410-X0520	Cable Set O_2 Service		M				5						1	3	1	5	C
410-X0521	Cable Set Gas Service		M				5						1	3	1	5	C
420-X0091	See Flight 509-E-2		M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0106	Alignment Gage SMS		G	O					3				1	1	1	3	E
420-X0107	Sling, SMS		G	O					3				1	1	1	3	E
420-X0108	Dolly, SMS		G	O					3				1	1	1	3	E
420-X0109	Sling, Dock & Launch		G	O					3				1	1	1	3	E
420-X0110	Dolly Dock & Launch		G	O					3				1	1	1	3	E
420-X0111	Fixture Install, SMS		M	O			4						1	2	1	4	C
420-X0112	Fixture Install, D&L		M	O			4						1	2	1	4	C
430-X0025	FDS - O_2		M				5						1	3	1	5	C
430-X0026	FDS - H_2O_2		M				5						1	3	1	5	C
430-X0027	FDS - Gas		M				5						1	3	1	5	C
430-X0033	Test Tool - H_2O_2		B				3						1	1	1	3	C

FLIGHT 509-E-7
EXPERIMENT: SMALL MANEUVERING SATELLITE
(Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod	LEM/Basic Add'l Mod	Integration New	Integration New	GFE Unmod	GFE Mod	GFE Add'l Unmod	GFE Add'l Mod	Sites				Misc
					CFE	CFE	CFE	GFE	GFE	GFE	GFE	GFE	MSC	ETR	Grumman	Total	
430-X0034	Valve Box - H_2O_2		B				5						1	3	1	5	C
430-X0035	Test Tool - H_2O_2 VB		B				3						1	1	1	3	C
430-X0036	O_2 - Stor, Cond & Trans Unit		B				5						1	3	1	5	C
430-X0037	H_2 Peroxide-Stor, Cond & Trans Unit		B				5						1	3	1	5	C
430-X0038	Inert Gas - Stor, Cond & Trans Unit		B				5						1	3	1	5	C
430-X0039	System Test Tool		B				3						1	1	1	3	C
430-X0040	O_2 Set Test Tool		B				3						1	1	1	3	C
430-X0041	Valve Box O_2		B				5						1	3	1	5	C
430-X0042	Test Tool - O_2 VB		B				3						1	1	1	3	C
430-X0043	Test Tool - Inert Gas		B				3						1	1	1	3	C
430-X0044	Valve Box - Inert Gas		B				5						1	3	1	5	C
430-X0045	Test Tool Inert Gas Valve Box		B				3						1	1	1	3	C

FLIGHT 509-E-8
EXPERIMENT: EXTENDABLE ROD

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
420-X0119	Fixt Checkout, Stem Rod		G	O					3				1	1	1	3	E

FLIGHT 509-E-9
EXPERIMENT: MAGNETOMETER

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0301	See Flight 507-E-4-B	C165	G	O					(4)				(1)	(2)	(1)	(4)	E
410-X0322	See Flight 507-E-4-B	C165	M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0076	See Flight 507-E-4-B		G	O					(4)				(1)	(2)	(1)	(4)	E
420-X0077	See Flight 507-E-4-B		M	O			(4)						(1)	(2)	(1)	(4)	C

FLIGHT 509-E-10
EXPERIMENT: PROPELLANT HANDLING
(Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Miles
410-X0025	Gas Contr Test Tool		M				3						1	1	1	3	C
410-X0507	Controller - H_2O		M				5						1	3	1	5	C
410-X0508	Controller - Gas		M				5						1	3	1	5	C
410-X0509	H_2O Contr Test Tool		M				3						1	1	1	3	C
410-X0511	Cable Set H_2O Serv		M				5						1	3	1	5	C
410-X0512	Cable Set - Gas Serv		M				5						1	3	1	5	C
420-X0113	Sling, H_2O Containers		G						3				1	1	1	3	E
420-X0114	Dolly, H_2O Containers		G						3				1	1	1	3	E
420-X0115	Sling, Fuel Trans Sys		G						3				1	1	1	3	E
420-X0116	Dolly, Fuel Trans Sys		G						3				1	1	1	3	E
420-X0117	Sling, He Tank		G						3				1	1	1	3	E
420-X0118	Dolly, He Tank		G						3				1	1	1	3	E
430-X0014	H_2O Stor & Trans Unit		B				5						1	3	1	5	C
430-X0015	System Test Tool		M				3						1	1	1	3	C
430-X0016	H_2O S&T Test Tool		B				3						1	1	1	3	C
430-X0017	FDS - H_2O		M				5						1	3	1	5	C
430-X0018	Valve Box - H_2O		B				5						1	3	1	5	C
430-X0019	H_2O VB Test Tool		B				3						1	1	1	3	C
430-X0020	Gas Stor & Trans Unit		B				5						1	3	1	5	C

FLIGHT 509-E-10
EXPERIMENT: PROPELLANT HANDLING
(Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
430-X0021	Valve Box - Gas		B				5						1	3	1	5	C
430-X0022	FDS - Gas		M				5						1	3	1	5	C
430-X0023	Gas VB Test Tool		B				3						1	1	1	3	C
430-X0024	Gas S&T Test Tool		B				3						1	1	1	3	C

FLIGHT 509-C-1
COMPATIBILITY EQUIPMENT: ENVIRONMENTAL COOLING SYSTEM (Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration Now CFE	Integration Now GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0528	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
410-X0529	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
410-X0530	See Flight 507-C-2		M				(3)						(1)	(1)	(1)	(3)	C
410-X0531	See Flight 507-C-2		M				(3)						(1)	(1)	(1)	(3)	C
410-X0532	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
410-X0533	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
430-X0001	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
430-X0002	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
430-X0003	See Flight 507-C-2		M				(3)						(1)	(1)	(1)	(3)	C
430-X0004	See Flight 507-C-2		M				(3)						(1)	(1)	(1)	(3)	C
430-4100-1	See Flight 507-C-2		G						(3)				(1)	(1)	(1)	(3)	L
430-4130-1	See Flight 507-C-2		G						(3)				(1)	(1)	(1)	(3)	L
430-4600-1	See Flight 507-C-2		G						(1)				-	-	(1)	(1)	L
430-52010-1	See Flight 507-C-2		G						(3)				(1)	(1)	(1)	(3)	L
430-52160-1	See Flight 507-C-2		G						(3)				(1)	(1)	(1)	(3)	L
430-52200-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L
430-52210-1	See Flight 507-C-2		G						(3)				(1)	(1)	(1)	(3)	L
430-54320-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L
430-54340-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L

FLIGHT 509-C-1
COMPATIBILITY EQUIPMENT: ENVIRONMENTAL COOLING SYSTEM
(Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
430-54700-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L
430-94019-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L
430-94052-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L
430-94119-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L

FLIGHT 509-C-2
COMPATIBILITY EQUIPMENT: COUNTER ROTATION PLATFORM (GN&C)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod	LEM/Basic Add'l Mod	Integration New	Integration New	GFE Unmod	GFE Mod	GFE Add'l Unmod	GFE Add'l Mod	Sites				Misc
					CFE	CFE	CFE	GFE	GFE	GFE	GFE	GFE	MSC	ETR	Grumman	Total	
410-X0406	Signal Stimuli		M				3						1	1	1	3	C
410-X0407	Adapter Electronics		M				3						1	1	1	3	C
410-X0408	BTME, Stable Platfm		M				3						1	1	1	3	C
420-X0091	See Flight 509-E-2		M				(4)						(1)	(2)	(1)	(4)	C
420-X0120	Alignment Gage		M				3						1	1	1	3	C
420-X0121	Sling		M				3						1	1	1	3	C
420-X0122	Dolly		M				3						1	1	1	3	C
420-X0123	Fixture, Instl		M				3						1	1	1	3	C

FLIGHT 509-C-3
COMPATIBILITY EQUIPMENT: CONTROLS & DISPLAYS
(Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0016	509 Adapt/410-42100-1 PNL 1		M	0			3						1	1	1	3	C
410-X0017	509 Adapt/410-42100-1 PNL 3		M	0			3						1	1	1	3	C
410-X0018	509 Adapt/410-42100-1 PNL 8		M	0			3						1	1	1	3	C
410-X0019	509 Adapt/410-42100-1 PNL 10		M	0			3						1	1	1	3	C
410-X0020	509 Adapt/410-42100-1 PNL 5		M	0			3						1	1	1	3	C
410-X0021	509 Adapt/410-42100-1 PNL 2		M	0			3						1	1	1	3	C
410-X0022	509 Adapt/410-42100-1 PNL 6		M	0			3						1	1	1	3	C
410-X0023	509 Adapt/410-42100-1 PNL 11		M	0			3						1	1	1	3	C
410-X0024	509 Adapt/410-42100-1 PNL 12		M	0			3						1	1	1	3	C
410-X0329	P/O 410-32280	C169	G	5						4			1	2	1	4	L
410-32281	Simulator	C169	G	5						4			1	2	1	4	L
410-32282	Monitor	C169	G	5						4			1	2	1	4	L
410-32283	Collimator	C169	G	5						4			1	2	1	4	L
410-42100-1	See Flight 507-C-7	D001	D	3						(3)			(1)	(1)	(1)	(3)	B
420-43001	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	(3)	B
420-43002	See Flight 507-C-7	D501	G	3						(3)			(1)	(1)	(1)	(3)	B
420-43003	See Flight 507-C-7	D501	G	3						(3)			(1)	(1)	(1)	(3)	B
420-43004	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	(3)	B
420-43005	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	(3)	B

FLIGHT 509-C-3
COMPATIBILITY EQUIPMENT: CONTROLS & DISPLAYS
(Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
420-43006	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	(3)	B
420-43007	See Flight 507-C-7	D501	G	3						(3)			(1)	(1)	(1)	(3)	B

FLIGHT 509-C-4
COMPATIBILITY EQUIPMENT: REMOTE CAMERAS

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
	Support Equipment For Remote Cameras To Be Identified At A Later Date.																

FLIGHT 509-C-5
COMPATIBILITY EQUIPMENT: RENDEZVOUS RADAR

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-3010-1	Equip RDR Suppt	C142	G	1					1				-	-	1	1	B
410-3220-1	Equip RDR Suppt Int	C114	G	1					1				-	-	1	1	B
410-11760-1	C/O Sta Radar Sect	C104	G	1					1				-	1	-	1	B
410-11760-5	C/O Sta Radar Sect	C104	G	1					1				1	-	-	1	B
410-11760-7	C/O Sta Radar Sect	C111	G	1					1				-	-	1	1	B
410-31010-1	Adapt C/O RR & LR	C106	G	8					7				1	3	3	7	B
410-31030-1	Adapt RR/LR Micro C/O	C109	G	4					4				1	1	2	4	B
410-31030-3	Adapt RR/LR Micro C/O	C108	G	3					1				-	-	1	1	B
410-31039-1	Adapt C/O Anechoic	C105	G	9					7				1	3	3	7	B
410-32520-1	Test Sta RR/LR Maint	C112	G	3					3				1	1	1	3	B
410-32530-1	Bench Test Cons RR/T	C113	G	1					1				-	-	1	1	B
420-13362	Align Gage, RR		G						3				1	1	1	3	L
420-23208	Handling Kit, Sign Proc		G							3			1	1	1	3	L
420-23214	Handling Kit, RR Elect		G						3				1	1	1	3	L
420-31016	Prot Cover, RR		G						3				1	1	1	3	L
420-33003	Install Kit, RR		G						3				1	1	1	3	L

FLIGHT 509-C-6
COMPATIBILITY EQUIPMENT: INSTRUMENTATION

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0002	Adapt C/509 For 410-92405	G002	M	0			3						1	1	1	3	C
410-X0325	See Flight 507-C-4	C166	M				(3)						(1)	(1)	(1)	(3)	C
410-X0309	See Flight 507-C-4	C166	M				(3)						(1)	(1)	(1)	(3)	C
410-X0310	See Flight 507-C-4	C166	M				(3)						(1)	(1)	(1)	(3)	C
410-92405	See Flight 507-M-1	G002	G	3					(3)				(1)	(1)	(1)	(3)	B

FLIGHT 509-C-7
COMPATIBILITY EQUIPMENT: SMS COMMUNICATIONS

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-32080-1	See Flight 507-E-10	C122	G	4					(4)				(1)	(1)	(2)	(4)	B
410-32150-1	See Flight 507-E-10	C125	G	2					(2)				"	(1)	(1)	(2)	B
410-32280-5	See Flight 507-E-10	C126	G	5					(5)				(1)	(2)	(2)	(5)	B
420-23209	Handling Kit, Transceiver		G							3			1	1	1	3	L

FLIGHT 509-C-8
COMPATIBILITY EQUIPMENT: POWER SUPPLY SUBSYSTEM

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-8139	See Flight 507-C-6	H015	G	1					(1)				-	-	(1)	(1)	E
410-8510	See Flight 507-C-6	H015	G	1					(1)				-	-	(1)	(1)	E
410-81070	See Flight 507-C-6	H015	G	6					(6)				-	(5)	(1)	(6)	E
410-82090	See Flight 507-C-6	H014	G	5						(3)			(1)	(1)	(1)	(3)	B
410-82100	See Flight 507-C-6	H014	G	3						(3)			(1)	(1)	(1)	(3)	B
410-82140	See Flight 507-C-6	H015	G	7					(1)				-	-	(1)	(1)	B
410-82150	See Flight 507-C-6	H016	G	2						(1)			-	-	(1)	(1)	B
410-82200	See Flight 507-C-6	H018	G	3					(3)				(1)	(1)	(1)	(3)	B
410-82400	See Flight 507-C-6	H019	G	3						(3)			(1)	(1)	(1)	(3)	B
420-23219	See Flight 507-C-6		G						(3)				(1)	(1)	(1)	(3)	L
420-23220	See Flight 507-C-6		G						(3)				(1)	(1)	(1)	(3)	L

FLIGHT 509-M-1
MISC. EQUIP. FOR FLT. 509
(Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-E0006	See Flight 507-M-1	G003	G	0					(1)				-	-	(1)	(1)	B
410-E0018	See Flight 507-M-1	G003	G	0					(3)				(1)	(1)	(1)	(3)	B
410-E0023	See Flight 507-M-1	G004	G	0					(2)				-	(1)	(1)	(2)	B
410-X0049	Site Adptr 410-92211 Flt 509	G002	M	0			3						1	1	1	3	C
410-X0050	Site Adptr 410-92212 Flt 509	G002	M	0			3						1	1	1	3	C
410-X0051	Site Adptr 410-92213 Flt 509	G002	M	0			3						1	1	1	3	C
410-7900-1	See Flight 507-M-1	G003	G	1					(3)				(1)	(1)	(1)	(3)	B
410-9450	See Flight 507-M-1	K004	M	1					(1)				-	-	(1)	(1)	M
410-9470	See Flight 507-M-L	K004	B	51					(21)				-	-	(21)	(21)	M
410-9472	See Flight 507-M-1	K004	B	3					(2)				-	-	(2)	(2)	M
410-9473	See Flight 507-M-1	K004	B	17					(17)				-	-	(17)	(17)	M
410-9480	See Flight 507-M-1	K004	B	2					(1)				-	-	(1)	(1)	M
410-11170	See Flight 507-M-1	K005	M	8						1			-	1	-	1	B
410-11170	See Flight 507-M-1	K005	M	8						(2)			(1)	-	(1)	(2)	M
410-11990	See Flight 507-M-1	K004	G	5						1			-	1	-	1	B
410-11990	See Flight 507-M-1	K004	G	5					(3)				(1)	(1)	(1)	(3)	M
410-12731	See Flight 507-M-1	K005	M	8						1			-	1	-	1	B
410-12731	See Flight 507-M-1	K005	M	8						(2)			(1)	-	(1)	(2)	M
410-72060-1	See Flight 507-M-1	G004	G	2					(2)				-	(1)	(1)	(2)	B

FLIGHT 509-M-1
MISC. EQUIP. FOR FLT. 509
(Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-92200	See Flight 507-M-1	K005	A	8						1			-	1	-	1	B
410-92200	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	M
410-92201	See Flight 507-M-1	K005	A	8						1			-	1	-	1	B
410-92201	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	M
410-92210	See Flight 507-M-1	K005	G	8					1				-	1	-	1	B
410-92210	See Flight 507-M-1	K005	G	8					(2)				(1)	-	(1)	(2)	B
410-92211	See Flight 507-M-1	K005	A	8						1			-	1	-	1	B
410-92211	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	M
410-92212	See Flight 507-M-1	K005	A	8						1			-	1	-	1	B
410-92212	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	M
410-92213	See Flight 507-M-1	K005	A	8						1			-	1	-	1	B
410-92213	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	M
410-92232	See Flight 507-M-1	K004	G	7					2				-	1	1	2	B
410-92232	See Flight 507-M-1	K004	G	7					(5)				(1)	(3)	(1)	(5)	B
410-92240	See Flight 507-M-1	K006	G	6					2				-	1	1	2	B
410-92240	See Flight 507-M-1	K006	G	6					(4)				-	(3)	(1)	(4)	B
410-92241	See Flight 507-M-1	K006	A	5						2			-	1	1	2	B
410-92241	See Flight 507-M-1	K006	A	5						(4)			-	(3)	(1)	(4)	M
410-92405	See Flight 507-M-1	G002	G	3					(3)				(1)	(1)	(1)	(3)	B

FLIGHT 214-E-1

EXPERIMENT: RADIATION MONITORING

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0301	See Flight 507-E-4-B	C165	G						(4)				(1)	(2)	(1)	(4)	E
410-X0304	See Flight 507-E-4-A	C174	G						(4)				(1)	(2)	(1)	(4)	E
410-X0305	See Flight 507-E-4-A	C174	M				(4)						(1)	(2)	(1)	(4)	C
410-X0321	See Flight 507-E-4-A	C174	M				(4)						(1)	(2)	(1)	(4)	C
410-X0322	See Flight 507-E-4-B	C165	M				(4)						(1)	(2)	(1)	(4)	C
420-X0001	See Flight 507-E-4-A		G						(4)				(1)	(2)	(1)	(4)	E
420-X0002	See Flight 507-E-4-A		M				(4)						(1)	(2)	(1)	(4)	C
420-X0003	See Flight 507-E-4-A		M				(4)						(1)	(2)	(1)	(4)	C
420-X0004	See Flight 507-E-4-A		M				(4)						(1)	(2)	(1)	(4)	C
420-X0005	See Flight 507-E-4-A		G						(4)				(1)	(2)	(1)	(4)	E
420-X0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C
420-X0076	See Flight 507-E-4-B		G						(4)				(1)	(2)	(1)	(4)	E
420-X0077	See Flight 507-E-4-B		M				(4)						(1)	(2)	(1)	(4)	C

FLIGHT 214-E-2

EXPERIMENT: CONTROL MOMENT GYRO

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod	LEM/Basic Add'l Mod	Integration New	Integration New	GFE Unmod	GFE Mod	GFE Add'l Unmod	GFE Add'l Mod	Sites				Misc
					CFE	CFE	CFE	GFE	GFE	GFE	GFE	GFE	MSC	ETR	Grumman	Total	
410-X0413	Signal, Stimuli		M				3						1	1	1	3	C
410-X0414	Adapter, Electronic		M				3						1	1	1	3	C
410-X0415	BTME, CMG		G						3				1	1	1	3	E
420-X0124	Dolly		G						3				1	1	1	3	E
420-X0125	Sling		G						3				1	1	1	3	E
420-X0126	Fixture, Installation		M				3						1	1	1	3	C
420-X0129	Optical Sighting Equip		M				3						1	1	1	3	C
420-X0193	Alignment Gage		G						3				1	1	1	3	E

FLIGHT 214-E-3

EXPERIMENT: OPT GUID SYST FOR RENDEZVOUS

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0122	Laser Test Set	C161	M				3						1	1	1	3	C
420-X0127	Alignment Gage		G						3				1	1	1	3	E
420-X0128	Target Source		G						3				1	1	1	3	E
420-X0129	Sighting Equipment		M				4						1	2	1	4	C
420-X0130	Handling Kit		G						3				1	1	1	3	E

FLIGHT 214-E-4

EXPERIMENT: DEPLOYMENT OF RF REFLECTIVE STRUCTURES

Part No.	Description	Functional Set	Source	Basis	LSM/Basic Addn'l Unmod GFE	LSM/Basic Addn'l Mod GFE	Integration Mfrg GFE	Integration Mfrg GFE	OFE Unmod GFE	OFE Mod GFE	OFE Addn'l Unmod GFE	OFE Addn'l Mod GFE	Sites: MSFC	Sites: ETR	Sites: Grumman	Sites: Pool	Rmks
420-X0131	Sling, Canister, Assy		G						3				1	1	1	3	E
420-X0132	Dolly, Canister, Assy		G						3				1	1	1	3	E

FLIGHT 214-E-5

EXPERIMENT: ON-BOARD GUIDANCE & NAVIGATION SYSTEM (Sheet 1 Of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-11760-1	See Flight 509-C-5	C104	G	1					(1)				-	(1)	-	(1)	B
410-11760-5	See Flight 509-C-5	C104	G	1					(1)				(1)	-	-	(1)	B
410-11760-7	See Flight 509-C-5	C111	G	1					(1)				-	-	(1)	(1)	B
410-31010-1	See Flight 509-C-5	C106	G	8					(7)				(1)	(3)	(3)	(7)	B
410-31020-1	Adptr C/O Land'g Radar Ant	C107	G	7					7				1	3	3	7	B
410-31030-1	See Flight 509-C-5	C109	G	4					(4)				(1)	(1)	(2)	(4)	B
410-31030-3	See Flight 509-C-5	C108	G	3					(1)				-	-	(1)	(1)	B
410-31050-1	Control Console LR	C102	G	1					1				-	1	-	1	B
410-32520-1	See Flight 509-C-5	C112	G	3					(3)				(1)	(1)	(1)	(3)	B

FLIGHT 214-E-5

EXPERIMENT: ON-BOARD GUIDANCE & NAVIGATION SYSTEM (Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Miles
420-X0129	Sighting Equip't		M				3						1	1	1	3	C
420-X0133	Align'mt Gage Star Tracker		B						3				1	1	1	3	E
420-X0134	Align'mt Gage Alt Doppler		B						3				1	1	1	3	E
420-X0135	Align'mt Gage Ant (1407)		B						3				1	1	1	3	E
420-X0136	Align'mt Gage Sun Sensor		B						3				1	1	1	3	E
420-X0137	Align'mt Gage Horizon Sensor		B						3				1	1	1	3	E
420-X0138	Target Source Sensors		B						3				1	1	1	3	E
420-X0139	Dolly, Altimeter		B						3				1	1	1	3	E
420-X0140	Sling, Altimeter		B						3				1	1	1	3	E
420-X0141	Fixture, Instl Alt		M				3						1	1	1	3	C
420-13362	See Flight 509-C-5		M						(3)				(1)	(1)	(1)	(3)	L
420-23214	See Flight 509-C-5		M						(3)				(1)	(1)	(1)	(3)	L
420-31016	See Flight 509-C-5		M						(3)				(1)	(1)	(1)	(3)	L
420-33003	See Flight 509-C-5		M						(3)				(1)	(1)	(1)	(3)	L

FLIGHT 214-E-6

EXPERIMENT: ORBITAL MANEUVERING & DOCKING (Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0123	Ruby Laser T/S	C162	M	O			3						1	1	1	3	C
410-X0128	Adptr C/O, Anechoic	C163	M	O			3						1	1	1	3	C
410-X0129	Adptr C/O, Long	C163	M	O			3						1	1	1	3	C
410-X0130	Adptr C/O L/R Radar	C163	M	O			3						1	1	1	3	C
410-X0326	Adptr Electronics	C168	M				3						1	1	1	3	C
410-11760-1	See Flight 507-E-13-A	C175	V	1						(1)			-	(1)	-	(1)	BM
410-11760-5	See Flight 507-E-13-A	C175	V	1						(1)			(1)	-	-	(1)	BM
410-11760-7	See Flight 507-E-13-A	C175	V	1						(1)			-	-	(1)	(1)	BM
420-X0129	Sight Equip		M	O			(4)						(1)	(2)	(1)	(4)	C
420-X0146	Hand Kit, Ruby Laser Elect		G	O					3				1	1	1	3	E
420-X0147	Align Gage, Ruby Laser		G	O					3				1	1	1	3	E
420-X0148	Target Source Ruby Laser		G	O					3				1	1	1	3	E
420-X0149	Dolly, Ruby Laser		G	O					3				1	1	1	3	E
420-X0150	Sling, Ruby Laser		G	O					3				1	1	1	3	E
420-X0151	Fixture Instl Ruby Laser		M	O			3						1	1	1	3	C
420-X0152	Dolly, Net. Capture Device		G	O					3				1	1	1	3	E
420-X0153	Sling, Net. Capture Device		G	O					3				1	1	1	3	E
420-X0154	Fix C/O Net. Capture Device		M	O			3						1	1	1	3	C
420-X0155	Dolly, Mag Capt Device		G	O					3				1	1	1	3	E

FLIGHT 214-E-6

EXPERIMENT: ORBITAL MANEUVERING & DOCKING (Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Ornonton	Sites Total	Sites
420-X0156	Sling, Mag Capt Device		G	O					3				1	1	1	3	E
420-X0157	Fix. C/O Mag Capt Device		M	O			3						1	1	1	3	C
420-X0158	Hand Kit LRR Elect		G	O					3				1	1	1	3	E
420-X0159	Sling, LRR Ant		G	O					3				1	1	1	3	E
420-X0160	Dolly, LRR Ant		G	O					3				1	1	1	3	E
420-X0161	Fix Instl LRR Ant		M	O			3						1	1	1	3	C
420-X0162	Align. Gage, LRR Ant		G	O					3				1	1	1	3	E
420-X0163	Fix C/O, Docking		M	O			1						-	1	-	1	C
420-X0164	Support, Ant Coup		M	O			3						1	1	1	3	C

FLIGHT 214-E-7

EXPERIMENT: PROPELLANT HANDLING
(Sheet 1 of 3)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0510	See Flight 509-E-7		M				(3)						(1)	(1)	(1)	(3)	C
410-X0513	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
410-X0514	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
410-X0515	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
410-X0519	See Flight 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
410-X0520	See Flight 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
410-X0521	See Flight 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
410-X0522	Trans & Cond Cont Console		M				3						1	1	1	3	C
410-X0523	Test Tool-Trans & Cond Cont Console		M				3						1	1	1	3	C
410-X0524	Cable Set-Lox Serv.		M				4						1	2	1	4	C
420-X0142	Dolly, Handling, Lox		G						3				1	1	1	3	E
420-X0143	Sling, Handling, Lox		G						3				1	1	1	3	E
420-X0144	Dolly, Handling, Pump		G						3				1	1	1	3	E
420-X0145	Sling, Handling, Pump		G						3				1	1	1	3	E
420-X0187	Sling, H_2O Containers		G						3				1	1	1	3	E
420-X0188	Dolly, H_2O Containers		G						3				1	1	1	3	E
420-X0189	Sling, Fuel Trans Sys		G						3				1	1	1	3	E
420-X0190	Dolly Fuel Trans Sys		G						3				1	1	1	3	E

FLIGHT 214-E-7

EXPERIMENT: PROPELLANT HANDLING
(Sheet 2 of 3)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
430-X0025	See 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
430-X0026	See 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
430-X0027	See 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
430-X0033	See 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0034	See 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
430-X0035	See 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0036	See 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
430-X0037	See 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
430-X0038	See 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
430-X0039	See 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0040	See 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0041	See 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
430-X0042	See 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0043	See 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0044	See 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
430-X0045	See 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0046	Lox-Storage Unit		B				3						1	1	1	3	C
430-X0047	Test Tool Lox- Storage Unit		B				3						1	1	1	3	C
430-X0048	Lox Trans & Cond Unit		B				3						1	1	1	3	C

FLIGHT 214-E-7

EXPERIMENT: PROPELLANT HANDLING
(Sheet 3 of 3)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
430-X0049	Test Tool - Lox Trans & Cond Unit		B				3						1	1	1	3	C
430-X0050	Sys Test Tool		B				3						1	1	1	3	C
430-X0051	FDS - LOX		M				4						1	2	1	4	C
430-X0052	Valve Box - Lox		B				3						1	1	1	3	C
430-X0053	Test Tool - Valve Box, Lox		B				3						1	1	1	3	C

FLIGHT 214-E-8

EXPERIMENT: SATELLITE SUPPORT EQUIPMENT

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0131	Micro'wv Hat, X-Band Transponder Ant	C164	M	0			3						-	-	3	3	C
410-3000-1	Test Sta Transponder Ant	C115	G	1					1				-	-	1	1	B
410-11760-1	See Flight 509-C-5	C104	G	1					(1)				-	(1)	-	(1)	B
410-11760-5	See Flight 509-C-5	C104	G	1					(1)				(1)	-		(1)	B
410-11760-7	See Flight 509-C-5	C111	G	1					(1)				-	-	(1)	(1)	B
410-31030-1	See Flight 509-C-5	C109	G	4					(4)				(1)	(1)	(2)	(4)	B
410-32020-1	See Flight 509-C-5	C121	G	4					(4)				-	(2)	(2)	(4)	B
410-32150-1	See Flight 509-C-7	C125	G	2					(2)				-	(1)	(1)	(2)	B
410-32520-1	See Flight 509-C-5	C112	G	3					(3)				(1)	(1)	(1)	(3)	B
410-32530-1	See Flight 509-C-5	C113	G	1					(1)				-	-	(1)	(1)	B
410-92112-1	C-Band C/O Unit	C127	G	3					3				1	1	1	3	B
410-92442-1	RF C/O Unit	C128	G	3					3				1	2	-	3	B
420-X0091	See Flight 509-E-2		M	0			(4)						(1)	(2)	(1)	(4)	C
420-X0106	See Flight 509-E-7		G	0					(3)				(1)	(1)	(1)	(3)	E
420-X0107	See Flight 509-E-7								(3)				(1)	(1)	(1)	(3)	E
420-X0108	See Flight 509-E-7								(3)				(1)	(1)	(1)	(3)	E
420-X0109	See Flight 509-E-7								(3)				(1)	(1)	(1)	(3)	E
420-X0110	See Flight 509-E-7								(3)				(1)	(1)	(1)	(3)	E
420-X0111	See Flight 509-E-7						(4)						(1)	(2)	(1)	(4)	C
420-X0112	See Flight 509-E-7						(4)						(1)	(2)	(1)	(4)	C

FLIGHT 214-C-1
COMPATIBILITY EQUIPMENT: CREW PROVISIONS

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Downtown	Sites Total	Sites Other
No Unique Support Equipment Identified In This Category																	

FLIGHT 214-C-2
COMPATIBILITY EQUIPMENT: PHOTOGRAPHIC

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod GFE	Integration Raw CFE	Integration Raw GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Cramerton	Sites Total	Miss
410-X0329	See Flight 509-C-3	C169	G	5						(4)			(1)	(2)	(1)	(4)	L
410-32281	See Flight 509-C-3	C169	G	5						(4)			(1)	(2)	(1)	(4)	L
410-32282	See Flight 509-C-3	C169	G	5						(4)			(1)	(2)	(1)	(4)	L
410-32283	See Flight 509-C-3	C169	G	5						(4)			(1)	(2)	(1)	(4)	L

FLIGHT 214-C-3
COMPATIBILITY EQUIPMENT: GUIDANCE, NAVIGATION & CONTROL

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Cnvention	Sites Total	Notes
410-3010-1	See Flight 509-C-5	C142	G	1					(1)				-	-	(1)	(1)	B
410-3220-1	See Flight 509-C-5	C114	G	1					(1)				-	-	(1)	(1)	B
410-11760-1	See Flight 509-C-5	C104	G	1					(1)				-	(1)	-	(1)	B
410-11760-5	See Flight 509-C-5	C104	G	1					(1)				(1)	-	-	(1)	B
410-11760-7	See Flight 509-C-5	C111	G	1					(1)				-	-	(1)	(1)	B
410-22950	Test Station CCS	B003	G	4					3				1	1	1	3	L
410-31010-1	See Flight 509-C-5	C106	G	8					(7)				(1)	(3)	(3)	(7)	B
410-31030-1	See Flight 509-C-5	C109	G	4					(4)				(1)	(1)	(2)	(4)	B
410-31030-3	See Flight 509-C-5	C108	G	3					(1)				-	-	(1)	(1)	B
410-31039-1	See Flight 509-C-5	C105	G	9					(7)				(1)	(3)	(3)	(7)	B
410-31058	Cont Temp IC	C003	G	7					3				1	1	1	3	L
410-31090	Cont Temp Lift	C004	G	2					1				-	1	-	1	L
410-32520-1	See Flight 509-C-5	C112	G	3					(3)				(1)	(1)	(1)	(3)	B
410-32530-1	See Flight 509-C-5	C113	G	1					(1)				-	-	(1)	(1)	B
420-31018	IMU Snap On Bellows		G	3					3				1	1	1	3	L
420-33019	IMU Handling Fixture		G	3					3				1	1	1	3	L
420-43007	Fixture, Dsky Install		G						3				1	1	1	3	L
420-53100	Dolly, Instl Cabin Equip		G						3				1	1	1	3	L
420-53200	Fixture, Insl Cabin Equip		G						3				1	1	1	3	L

FLIGHT 214-C-4
COMPATIBILITY EQUIPMENT: COMMUNICATIONS

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-32020-1	Probe Assy C-Band	C121	G	4					4				-	2	2	4	B
410-32080-1	See Flight 507-E-10	C122	G	4					(4)				(1)	(1)	(2)	(4)	B
410-32150-1	See Flight 507-E-10	C125	G	2					(2)				-	(1)	(1)	(2)	B
410-32280-5	See Flight 507-E-10	C126	G	5					(5)				(1)	(2)	(2)	(5)	B
410-92112-1	See Flight 214-E-8	C127	G	3					(3)				(1)	(1)	(1)	(3)	B
410-92442-1	See Flight 214-E-8	C128	G	3					(3)				(1)	(2)	-	(3)	B
420-13362	See Flight 509-C-5		G						(3)				(1)	(1)	(1)	(3)	L
420-23208	See Flight 509-C-5		G						(3)				(1)	(1)	(1)	(3)	L
420-23209	See Flight 509-C-7		G						(3)				(1)	(1)	(1)	(3)	L
420-23214	See Flight 509-C-5		G						(3)				(1)	(1)	(1)	(3)	L
420-31016	See Flight 509-C-5		G						(3)				(1)	(1)	(1)	(3)	L
420-33003	See Flight 509-C-5		G						(3)				(1)	(1)	(1)	(3)	L

FLIGHT 214-C-5
COMPATIBILITY EQUIPMENT: INSTRUMENTATION

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Sites
410-X0003	Adptr C214 For 410-92405	G002	M	0			3						1	1	1	3	C
410-X0325	See Flight 507-C-4	C166	M				(3)						(1)	(1)	(1)	(3)	C
410-X0309	See Flight 507-C-4	C166	M				(3)						(1)	(1)	(1)	(3)	C
410-X0310	See Flight 507-C-4	C166	M				(3)						(1)	(1)	(1)	(3)	C
410-92405	See Flight 507-M-1	G002	G	3					(3)				(1)	(1)	(1)	(3)	B

FLIGHT 214-C-6

COMPATIBILITY EQUIPMENT: ELECTRICAL POWER SYSTEM

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-8139	See Flight 507-C-6	H015	G	1					(1)				-	-	(1)	(1)	BM
410-8510	See Flight 507-C-6	H015	G	1					(1)				-	-	(1)	(1)	BM
410-81070	See Flight 507-C-6	H015	G	6					(6)				-	(5)	(1)	(6)	BM
410-82090	See Flight 507-C-6	H014	G	5						(3)			(1)	(1)	(1)	(3)	BM
410-82100	See Flight 507-C-6	H014	G	3						(3)			(1)	(1)	(1)	(3)	BM
410-82140	See Flight 507-C-6	H015	G	7					(1)				-	-	(1)	(1)	BM
410-82150	See Flight 507-C-6	H016	G	2						(1)			-	-	(1)	(1)	BM
410-82200	See Flight 507-C-6	H018	G	3					(3)				(1)	(1)	(1)	(3)	BM
410-82400	See Flight 507-C-6	H019	G	3						(3)			(1)	(1)	(1)	(3)	BM
420-23219	See Flight 507-C-6		G						114				38	38	38	114	L
420-23220	See Flight 507-C-6		G						27				9	9	9	27	L
420-83210	Cont Ship Batt Temp Cond.		G						114				38	38	38	114	L
420-83240	Cart, Support & Check Batt		G						57				19	19	19	57	L
420-83280	Stor. Rack, Temp Batt		G						9				3	3	3	9	L

FLIGHT 214-C-7
COMPATIBILITY EQUIPMENT: ENVIRONMENTAL CONTROL SYSTEM
(Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Mfrs
410-X0528	See Flight 507-C-5		M				(5)						(1)	(3)	(1)	(5)	C
410-X0529	See Flight 507-C-5		M				(5)						(1)	(3)	(1)	(5)	C
410-X0530	See Flight 507-C-5		M				(3)						(1)	(1)	(1)	(3)	C
410-X0531	See Flight 507-C-5		M				(3)						(1)	(1)	(1)	(3)	C
410-X0532	See Flight 507-C-5		M				(5)						(1)	(3)	(1)	(5)	C
410-X0533	See Flight 507-C-5		M				(5)						(1)	(3)	(1)	(5)	C
430-X0001	See Flight 507-C-5		M				(5)						(1)	(3)	(1)	(5)	C
430-X0002	See Flight 507-C-5		M				(5)						(1)	(3)	(1)	(5)	C
430-X0003	See Flight 507-C-5		M				(3)						(1)	(1)	(1)	(3)	C
430-X0004	See Flight 507-C-5		M				(3)						(1)	(1)	(1)	(3)	C
430-4100-1	See Flight 507-C-5		G						(3)				(1)	(1)	(1)	(3)	L
430-4130-1	See Flight 507-C-5		G						(3)				(1)	(1)	(1)	(3)	L
430-4600-1	See Flight 507-C-5		G						(3)				(1)	(1)	(1)	(3)	L
430-52010-1	See Flight 507-C-5		G						(3)				(1)	(1)	(1)	(3)	L
430-52160-1	See Flight 507-C-5		G						(3)				(1)	(1)	(1)	(3)	L
430-52200-1	See Flight 507-C-5		G						(5)				(1)	(3)	(1)	(5)	L
430-52210-1	See Flight 507-C-5		G						(3)				(1)	(1)	(1)	(3)	L
430-54320-1	See Flight 507-C-5		G						(5)				(1)	(3)	(1)	(5)	L
430-54340-1	See Flight 507-C-5		G						(5)				(1)	(3)	(1)	(5)	L

FLIGHT 214-C-7
COMPATIBILITY EQUIPMENT: ENVIRONMENTAL CONTROL SYSTEM
(Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
430-54700-1	See Flight 507-C-5		G						(5)				(1)	(3)	(1)	(5)	L
430-94019-1	See Flight 507-C-5		G						(5)				(1)	(3)	(1)	(5)	L
430-94052-1	See Flight 507-C-5		G						(5)				(1)	(3)	(1)	(5)	L
430-94119-1	See Flight 507-C-5		G						(5)				(1)	(3)	(1)	(5)	L

FLIGHT 214-C-8

COMPATIBILITY EQUIPMENT: CONTROLS & DISPLAYS

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Ascension	Sites Total	Note
410-X0025	Adptr/410-42000-1,214 PNL 1	D001	M	0			3						1	1	1	3	C
410-X0026	Adptr/410-42000-1,214 PNL 3	D001	M	0			3						1	1	1	3	C
410-X0027	Adptr/410-42000-1,214 PNL 8	D001	M	0			3						1	1	1	3	C
410-X0028	Adptr/410-42000-1,214 PNL 10	D001	M	0			3						1	1	1	3	C
410-X0029	Adptr/410-42000-1,214 PNL 2	D001	M	0			3						1	1	1	3	C
410-X0030	Adptr/410-42000-1,214 PNL 6	D001	M	0			3						1	1	1	3	C
410-X0031	Adptr/410-42000-1,214 PNL 11	D001	M	0			3						1	1	1	3	C
410-X0032	Adptr/410-42000-1,214 PNL 12	D001	M	0			3						1	1	1	3	C
410-42100-1	See Flight 507-C-7	D001	D	3			-			(3)			(1)	(1)	(1)	3	B
420-43001	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	3	B
420-43002	See Flight 507-C-7	D501	G	3						(3)			(1)	(1)	(1)	3	B
420-43003	See Flight 507-C-7	D501	G	3						(3)			(1)	(1)	(1)	3	B
420-43004	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	3	B
420-43005	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	3	B
420-43006	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	3	B
420-43007	See Flight 507-C-7	D501	G	3						(3)			(1)	(1)	(1)	3	B

FLIGHT 214-C-9

COMPATIBILITY EQUIPMENT: STRUCTURE

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
Support Equipment For Structure																	
To Be Identified At A Later Date																	

FLIGHT 214-C-10

COMPATIBILITY EQUIPMENT: PROPULSION

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
No Unique Support Equipment Required For Propulsion Compatibility.																	

FLIGHT 214-M-1

MISC EQUIP FOR FLT 214 (Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-E0006	See Flight 507-M-1	G003	G	0					(1)				-	-	(1)	(1)	B
410-E0018	See Flight 507-M-1	G003	G	0					(3)				(1)	(1)	(1)	(3)	B
410-E0023	See Flight 507-M-1	G004	G	0					(2)				-	(1)	(1)	(2)	B
410-X0052	Site Adptr/410-92211 FLT214	G002	M	9			3						1	1	1	3	C
410-X0053	Site Adptr/410-92212 FLT214	G002	M	0			3						1	1	1	3	C
410-X0054	Site Adptr/410-92213 FLT214	G002	M	0			3						1	1	1	3	C
410-7900-1	See Flight 507-M-1	G003	G	1					(3)				(1)	(1)	(1)	(3)	MB
410-9450	See Flight 507-M-1	K004	M	1					(1)				-	-	(1)	(1)	MB
410-9470	See Flight 507-M-1	K004	B	51					(21)				-	-	(21)	(21)	MB
410-9473	See Flight 507-M-1	K004	B	17					(17)				-	-	(17)	(17)	MB
410-9472	See Flight 507-M-1	K004	B	3					(2)				-	-	(2)	(2)	MB
410-9480	See Flight 507-M-1	K004	B	2					(1)				-	-	(1)	(1)	MB
410-11170	See Flight 507-M-1	K005	M	8						1			-	1	-	1	B
410-11170	See Flight 507-M-1	K005	M	8						(2)			(1)	-	(1)	(2)	MB
410-11990	See Flight 507-M-1	K004	G	5					(4)				(1)	(2)	(1)	(4)	MB
410-72060-1	See Flight 507-M-1	G004	G	2					(2)				-	(1)	(1)	(2)	B
410-92200	See Flight 507-M-1	K005	A	8						1			-	1	-	1	B
410-92200	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	MB
410-92201	See Flight 507-M-1	K005	A	8						1			-	1	-	1	B

FLIGHT 214-M-1

MISC EQUIP FOR FLT 214 (Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-92201	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	MB
410-92210	See Flight 507-M-1	K005	G	8					1				-	1	-	1	B
410-92210	See Flight 507-M-1	K005	G	8					(2)				(1)	-	(1)	(2)	MB
410-92211	See Flight 507-M-1	K005	A	8						1			-	1	-	1	B
410-92211	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	MB
410-92212	See Flight 507-M-1	K005	A	8						1			-	1	-	1	B
410-92212	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	MB
410-92213	See Flight 507-M-1	K005	A	8						1			-	1	-	1	B
410-92213	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	MB
410-92232	See Flight 507-M-1	K004	G	7					2				-	1	1	2	B
410-92232	See Flight 507-M-1	K004	G	7					(7)				(1)	(4)	(2)	(7)	B
410-92240	See Flight 507-M-1	K006	G	6					(6)				-	(4)	(2)	(6)	B
410-92241	See Flight 507-M-1	K006	A	5						(6)			-	(4)	(2)	(6)	MB
410-92405	See Flight 507-M-1	G002	G	3					(3)				(1)	(1)	(1)	(3)	B

FLIGHT 216-E-1-A

EXPERIMENT: RADIATION MONITORING

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X-0304	See Flight 507-E-4-A	C174	G						(4)				(1)	(2)	(1)	(4)	E
410-X-0305	See Flight 507-E-4-A	C174	M				(4)						(1)	(2)	(1)	(4)	C
410-X-0321	See Flight 507-E-4-A	C174	M				(4)						(1)	(2)	(1)	(4)	C
420-X-0001	See Flight 507-E-4-A		G				(4)						(1)	(2)	(1)	(4)	C
420-X-0002	See Flight 507-E-4-A		M				(4)						(1)	(2)	(1)	(4)	C
420-X-0003	See Flight 507-E-4-A		M				(4)						(1)	(2)	(1)	(4)	C
420-X-0004	See Flight 507-E-4-A		M				(4)						(1)	(2)	(1)	(4)	C
420-X-0005	See Flight 507-E-4-A		G						(4)				(1)	(2)	(1)	(4)	E
420-X-0006	See Flight 507-E-1		M				(4)						(1)	(2)	(1)	(4)	C

FLIGHT 216-E-1-B

EXPERIMENT: MAGNETOMETER

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X-0301	See Flight 507-E-4-B	C165	G						(4)				(1)	(2)	(1)	(4)	E
410-X-0322	See Flight 507-E-4-B	C165	M				(4)						(1)	(2)	(1)	(4)	C
420-X-0076	See Flight 507-E-4-B		G						(4)				(1)	(2)	(1)	(4)	E
420-X-0077	See Flight 507-E-4-B		M				(4)						(1)	(2)	(1)	(4)	C

FLIGHT 216-E-2

EXPERIMENT: CAPILLARITY

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X-0312	Capillary Test Set	C167	G						3				1	1	1	3	E
420-X-0165	Sling, Exp Package		G						3				1	1	1	3	E
420-X-0166	Dolly, Exp Package		G						3				1	1	1	3	E

FLIGHT 216-E-3

EXPERIMENT: EVA SPACESUIT

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
420-X0167	Sling, Spacesuit		G						3				1	1	1	3	E
420-X0168	Dolly, Spacesuit		G						3				1	1	1	3	E
420-X0169	Sling, AMU		G						3				1	1	1	3	E
420-X0170	Dolly, AMU		G						3				1	1	1	3	E
420-X0171	Sling, Fuel Supply AMU		G						3				1	1	1	3	E
420-X0172	Dolly Fuel Supply AMU		G						3				1	1	1	3	E
420-X0173	Sling, Plate & Rails I		M				3						1	1	1	3	C
420-X0174	Dolly, Plate & Rails I		M				3						1	1	1	3	C

FLIGHT 216-E-4

EXPERIMENT: EVA LOCOMOTION & MANEUVERING

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration Now CFE	Integration Now GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
420-X0167	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0168	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0169	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0170	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0171	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0172	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0175	Sling, Cargo Nets		M				3						1	1	1	3	C
420-X0176	Dolly, Cargo Nets		M				3						1	1	1	3	C

FLIGHT 216-E-5

EXPERIMENT: EVA RESCUE OPERATIONS

Part No.	Description	Functional Set	Source	Base	LEM/Taxis Add'l Unmod GFE	LEM/Taxis Add'l Mod GFE	Integration Flow GFE	Integration Flow GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Ermonton	Sites Total	Sites
420-X0167	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0168	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0169	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0170	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0171	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0172	See Flight 216-E-3		G						(3)				(1)	(1)	(1)	(3)	E
420-X0180	Sling, Plate & Rails II		M				3						1	1	1	3	C
420-X0181	Dolly, Plate & Rails II		M				3						1	1	1	3	C
420-X0182	Sling, Test Objects		M				3						1	1	1	3	C
420-X0183	Dolly, Test Objects		M				3						1	1	1	3	C

FLIGHT 216-E-6

EXPERIMENT: EVA PERSONNEL & CARGO TRANSFER

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
420-X0167	See Flight 216-E-3			G					(3)				(1)	(1)	(1)	(3)	E
420-X0168	See Flight 216-E-3			G					(3)				(1)	(1)	(1)	(3)	E
420-X0169	See Flight 216-E-3			G					(3)				(1)	(1)	(1)	(3)	E
420-X0170	See Flight 216-E-3			G					(3)				(1)	(1)	(1)	(3)	E
420-X0171	See Flight 216-E-3			G					(3)				(1)	(1)	(1)	(3)	E
420-X0172	See Flight 216-E-3			G					(3)				(1)	(1)	(1)	(3)	E
420-X0184	Sling, Motor/Reel Set			M			3						1	1	1	3	C
420-X0185	Dolly, Motor/Reel Set			M			3						1	1	1	3	C
420-X0186	Fixture, C/O M/R Set			M			3						1	1	1	3	C
420-X0182	See Flight 216-E5			M			(3)						(1)	(1)	(1)	(3)	C
420-X0183	See Flight 216-E5			M			(3)						(1)	(1)	(1)	(3)	C

FLIGHT 216-E-7

EXPERIMENT: EVA SUPPORT EQUIPMENT

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites: MSC	Sites: ETR	Sites: Grumman	Sites: Total	Misc
No Ground Support Equipment is																	
Required For This Experiment																	

FLIGHT 216-E-8

EXPERIMENT: HANDLING PROPELLANT

(Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod GFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0510	See Flight 509-E-7		M				(3)						(1)	(1)	(1)	(3)	C
410-X0513	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
410-X0514	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
410-X0515	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
410-X0519	See Flight 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
410-X0520	See Flight 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
410-X0521	See Flight 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
420-X0187	See Flight 214-E-7		G						(3)				(1)	(1)	(1)	(3)	E
420-X0188	See Flight 214-E-7		G						(3)				(1)	(1)	(1)	(3)	E
420-X0189	See Flight 214-E-7		G						(3)				(1)	(1)	(1)	(3)	E
420-X0190	See Flight 214-E-7		G						(3)				(1)	(1)	(1)	(3)	E
430-X0025	See Flight 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
430-X0026	See Flight 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
430-X0027	See Flight 509-E-7		M				(5)						(1)	(3)	(1)	(5)	C
430-X0033	See Flight 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0034	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
430-X0035	See Flight 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0036	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
430-X0037	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C

FLIGHT 216-E-8

EXPERIMENT: HANDLING PROPELLANT

(Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
430-X0038	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
430-X0039	See Flight 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0040	See Flight 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0041	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
430-X0042	See Flight 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0043	See Flight 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C
430-X0044	See Flight 509-E-7		B				(5)						(1)	(3)	(1)	(5)	C
430-X0045	See Flight 509-E-7		B				(3)						(1)	(1)	(1)	(3)	C

FLIGHT 216-E-9

EXPERIMENT: EXPANDABLE AIR-LOCK

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
420-X0177	Sling, Airlock		B				3						1	1	1	3	C
420-X0178	Dolly, Airlock		B				3						1	1	1	3	C
420-X0179	Fixture, Checkout, Airlock		M				3						1	1	1	3	C

FLIGHT 216-E-10

EXPERIMENT: EXTENDABLE ROD

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
420-X0119	See Flight 509-E-8		G						(3)				(1)	(1)	(1)	(3)	E
420-X0191	Fix. Check, Wire Filament		G						3				1	1	1	3	E

FLIGHT 216-C-1

COMPATIBILITY EQUIPMENT: CREW PROVISIONS

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites [illegible]	Sites Total	Misc
No Unique	Support Equipment Identified																
in This Category																	

FLIGHT 216-C-2

COMPATIBILITY EQUIPMENT: PHOTOGRAPHIC

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0329	See Flight 509-C-3	C169	G	5						(4)			(1)	(2)	(1)	(4)	L
410-32281	See Flight 509-C-3	C169	G	5						(4)			(1)	(2)	(1)	(4)	L
410-32282	See Flight 509-C-3	C169	G	5						(4)			(1)	(2)	(1)	(4)	L
410-32283	See Flight 509-C-3	C169	G	5						(4)			(1)	(2)	(1)	(4)	L

FLIGHT 216-C-3

COMPATIBILITY EQUIPMENT: COMMUNICATIONS

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration Now CFE	Integration Now GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Cranmion	Sites Total	Sites
410-32020-1	See Flight 214-C-4	C121	G	4					(4)	( )			-	(2)	(2)	(4)	B
410-32080-1	See Flight 507-E-10	C122	G	4					(4)				(1)	(1)	(2)	(4)	B
410-32150-1	See Flight 507-E-10	C125	G	2					(2)				-	(1)	(1)	(2)	B
410-32280-5	See Flight 507-E-10	C126	G	5					(5)				(1)	(2)	(2)	(5)	B
410-92112-1	See Flight 214-C-4	C127	G	3					(3)				(1)	(1)	(1)	(3)	B
410-92442-1	See Flight 214-C-4	C128	G	3					(3)				(1)	(2)	-	(3)	B

FLIGHT 216-C-4

COMPATIBILITY EQUIPMENT: INSTRUMENTATION

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0004	Adapt C/216 for 410-92405	G002	M	0			3						(1)	1	1	3	C
410-X0325	See Flight 507-C-4	C166	M				(3)						(1)	(1)	(1)	(3)	C
410-X0309	See Flight 507-C-4	C166	M				(3)						(1)	(1)	(1)	(3)	C
410-X0310	See Flight 507-C-4	C166	M				(3)						(1)	(1)	(1)	(3)	C
410-92405	See Flight 507-M-1	G002	G	3					(3)				(1)	(1)	(1)	(3)	B

FLIGHT 216-C-5

COMPATIBILITY EQUIPMENT: STRUCTURE

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Miles
	Support Equipment For Structure to be Identified at a Later Date																

FLIGHT 216-C-6

COMPATIBILITY EQUIPMENT: GUIDANCE, NAVIGATION & CONTROL

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-22950	See Flight 214-C-3	B003	G	4					(3)				(1)	(1)	(1)	(3)	L
420-23207	Handling Kit, PCA		G	7					3				1	1	1	3	L

FLIGHT 216-C-7

COMPATIBILITY EQUIPMENT: ELECTRICAL POWER SYSTEM

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Misc MSC	Misc ETR	Misc Downrange	Misc Total	Misc
410-8139	See Flight 507-C-6	HO15	G	1					(1)				-	-	(1)	(1)	BM
410-8510	See Flight 507-C-6	HO15	G	1					(1)				-	-	(1)	(1)	BM
410-81070	See Flight 507-C-6	HO15	G	6					(6)				-	(5)	(1)	(6)	BM
410-82090	See Flight 507-C-6	HO14	G	5						(3)			(1)	(1)	(1)	(3)	BM
410-82100	See Flight 507-C-6	HO14	G	3						(3)			(1)	(1)	(1)	(3)	BM
410-82140	See Flight 507-C-6	HO15	G	7					(1)				-	-	(1)	(1)	BM
410-82150	See Flight 507-C-6	HO16	G	2						(1)			-	-	(1)	(1)	BM
410-82200	See Flight 507-C-6	HO18	G	3					(3)				(1)	(1)	(1)	(3)	BM
410-82400	See Flight 507-C-6	HO19	G	3						(3)			(1)	(1)	(1)	(3)	BM
420-23210	Hand. Fix ECA A/S		G						12				4	4	4	12	L
420-23218	Hand. Fix BAT A/S		G						60				20	20	20	60	L
420-23219	See Flight 507-C-6		G						90				30	30	30	90	L
420-23220	See Flight 507-C-6		G						21				7	7	7	21	L
420-83210	Cont Ship Bat Temp Cond		G						150				50	50	50	150	L
420-83240	Cart, Support & Check Bat		G						75				25	25	25	75	L
420-83280	Stor Rack Temp Bat		G						(9)				(3)	(3)	(3)	(9)	L
420-83280	Stor Rack Temp Bat		G						3				1	1	1	3	L

FLIGHT 216-C-8

COMPATIBILITY EQUIPMENT: ENVIRONMENTAL CONTROL SYSTEM
(Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Miles
410-X0528	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
410-X0529	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
410-X0530	See Flight 507-C-2		M				(3)						(1)	(1)	(1)	(3)	C
410-X0531	See Flight 507-C-2		M				(3)						(1)	(1)	(1)	(3)	C
410-X0532	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
410-X0533	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
430-X0001	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
430-X0002	See Flight 507-C-2		M				(5)						(1)	(3)	(1)	(5)	C
430-X0003	See Flight 507-C-2		M				(3)						(1)	(1)	(1)	(3)	C
430-X0004	See Flight 507-C-2		M				(3)						(1)	(1)	(1)	(3)	C
430-4100-1	See Flight 507-C-2		G						(3)				(1)	(1)	(1)	(3)	L
430-4130-1	See Flight 507-C-2		G						(3)				(1)	(1)	(1)	(3)	L
430-4600-1	See Flight 507-C-2		G						(1)				-	-	(1)	(1)	L
430-52010-1	See Flight 507-C-2		G						(3)				(1)	(1)	(1)	(3)	L
430-52160-1	See Flight 507-C-2		G						(3)				(1)	(1)	(1)	(3)	L
430-52200	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L
430-52210-1	See Flight 507-C-2		G						(3)				(1)	(1)	(1)	(3)	L
430-54320-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L
430-54340-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L

FLIGHT 216-C-8
COMPATIBILITY EQUIPMENT: ENVIRONMENTAL CONTROL SYSTEM (Sheet 2 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
430-54700-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L
430-94019-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L
430-94052-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L
430-94119-1	See Flight 507-C-2		G						(5)				(1)	(3)	(1)	(5)	L

FLIGHT 216-C-9

COMPATIBILITY EQUIPMENT: CONTROL & DISPLAYS

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-X0033	Adptr/410-42100,216 PNL 1	D001	M	0			3						1	1	1	3	C
410-X0034	Adptr/410-42100,216 PNL 3	D001	M	0			3						1	1	1	3	C
410-X0035	Adptr/410-42100,216 PNL 8	D001	M	0			3						1	1	1	3	C
410-X0036	Adptr/410-42100,216 PNL 10	D001	M	0			3						1	1	1	3	C
410-X0037	Adptr/410-42100,216 PNL 5	D001	M	0			3						1	1	1	3	C
410-X0038	Adptr/410-42100,216 PNL 2	D001	M	0			3						1	1	1	3	C
410-X0039	Adptr/410-42100,216 PNL 6	D001	M	0			3						1	1	1	3	C
410-X0040	Adptr/410-42100,216 PNL 11	D001	M	0			3						1	1	1	3	C
410-X0041	Adptr/410-42100,216 PNL 12	D001	M	0			3						1	1	1	3	C
410-42100-1	See Flight 507-C-7	D001	D	3						(3)			(1)	(1)	(1)	(3)	B
420-43001	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	(3)	B
420-43002	See Flight 507-C-7	D501	G	3						(3)			(1)	(1)	(1)	(3)	B
420-43003	See Flight 507-C-7	D501	G	3						(3)			(1)	(1)	(1)	(3)	B
420-43004	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	(3)	B
420-43005	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	(3)	B
420-43006	See Flight 507-C-7	D501	G	7						(3)			(1)	(1)	(1)	(3)	B
420-43007	See Flight 507-C-7	D501	G	3						(3)			(1)	(1)	(1)	(3)	B

FLIGHT 216-C-10

COMPATIBILITY EQUIPMENT: PROPULSION

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Misc MSC	Misc ETR	Misc Grumman	Misc Total	Misc
	No Unique Support Equipment Required For Propulsion Compatibility																

FLIGHT 216-M-1

MISC EQUIP FOR FLT 216
(Sheet 1 of 2)

Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration Now CFE	Integration Now GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-E0006	See Flight 507-M-1	G003	G	0					(1)				-	-	(1)	(1)	B
410-E0018	See Flight 507-M-1	G003	G	0					(3)				(1)	(1)	(1)	(3)	B
410-E0023	See Flight 507-M-1	G004	G	0					(2)				-	(1)	(1)	(2)	B
410-X0055	Site Adptr/410-92211 FLT 216	G002	M	0			3						1	1	1	3	C
410-X0056	Site Adptr/410-92212 FLT 216	G002	M	0			3						1	1	1	3	C
410-X0057	Site Adptr/410-92213 FLT 216	G002	M	0			3						1	1	1	3	C
410-7900-1	See Flight 507-M-1	G003	G	1					(3)				(1)	(1)	(1)	(3)	B
410-9450	See Flight 507-M-1	K004	G	1					(1)				-	-	(1)	(1)	M
410-9470	See Flight 507-M-1	K004	G	51					(21)				-	-	(21)	(21)	M
410-9472	See Flight 507-M-1	K004	G	3					(2)				-	-	(2)	(2)	M
410-9473	See Flight 507-M-1	K004	G	17					(17)				-	-	(17)	(17)	M
410-9480	See Flight 507-M-1	K004	G	2					(1)				-	-	(1)	(1)	M
410-11170	See Flight 507-M-1	K005	M	8					1				-	1	-	1	L
410-11170	See Flight 507-M-1	K005	M	8					(2)				(1)	-	(1)	(2)	M
410-11990	See Flight 507-M-1	K004	G	5					(4)				(1)	(2)	(1)	(4)	M
410-12731	See Flight 507-M-1	K005	M	8					1				-	1	-	1	L
410-12731	See Flight 507-M-1	K005	M	8					(2)				(1)	-	(1)	(2)	M
410-72060-1	See Flight 507-M-1	G004	G	2					(2)				-	(1)	(1)	(2)	B
410-92200	See Flight 507-M-1	K005	A	8						1			-	1	-	1	L

FLIGHT 216-M-1

MISC EQUIP FOR FLT 216
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Part No.	Description	Functional Set	Source	Base	LEM/Basic Add'l Unmod CFE	LEM/Basic Add'l Mod CFE	Integration New CFE	Integration New GFE	GFE Unmod GFE	GFE Mod GFE	GFE Add'l Unmod GFE	GFE Add'l Mod GFE	Sites MSC	Sites ETR	Sites Grumman	Sites Total	Misc
410-92200	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	M
410-92201	See Flight 507-M-1	K005	A	8						1			-	1	-	1	L
410-92201	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	M
410-92210	See Flight 507-M-1	K005	G	8					1				-	1	-	1	L
410-92210	See Flight 507-M-1	K005	G	8					(2)				(1)	-	(1)	(2)	M
410-92211	See Flight 507-M-1	K005	A	8						1			-	1	-	1	L
410-92211	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	M
410-92212	See Flight 507-M-1	K005	A	8						1			-	1	-	1	L
410-92212	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	M
410-92213	See Flight 507-M-1	K005	A	8						1			-	1	-	1	L
410-92213	See Flight 507-M-1	K005	A	8						(2)			(1)	-	(1)	(2)	M
410-92232	See Flight 507-M-1	K004	G	7					(9)				(1)	(5)	(3)	(9)	B
410-92240	See Flight 507-M-1	K006	G	6					(7)				-	(5)	(2)	(7)	B
410-92241	See Flight 507-M-1	K006	A	5						(7)			-	(5)	(2)	(7)	M
410-92405	See Flight 507-M-1	G002	G	3					(3)				(1)	(1)	(1)	(3)	B